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Agriculture and Animal Husbandry in India

1936-37

Issued under the Authority
of
The Imperial Council of Agricultural Research

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1936-37

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PREFACE

THE present volume records the progress made in all branches of agriculture and animal husbandry research and development throughout the year 1936-37. During that year Sir John Russell, Director of Rothamsted Experimental Station, and Dr. N. C. Wright of the Hannah Dairy Institute, Ayrshire, visited India at the invitation of the Imperial Council of Agricultural Research. The reports of both these scientists have been published and are available as priced* publications, and are discussed in Chapter II of the present volume. There are also two other special chapters—one on *Fruit Development* and the other on *Fodder Crops and Grazing*. Both these subjects usually appear as ordinary sections of this annual volume. The new departure lies in taking these two subjects and giving them rather more detailed treatment. It is hoped in succeeding years to give the same sort of treatment to other subjects, so that in the course of a few years practically every major branch of agricultural research will have received attention in a special chapter. In the other parts of the volume, an attempt has been made to cut out unnecessary detail and concentrate more on the actual work of the year. It is hoped that this volume, like its predecessors, will be found useful for reference by all interested in the development of this great industry. It includes references to all reports received up to the beginning of May, 1938.

* Report on the Work of Imperial Council of Agricultural Research in Applying Science to Crop Production in India, by Sir John Russell, D.Sc., F.R.S. Price Re. 1-14 or 3*s*. 3*d*.

Report on the Development of Cattle and Dairy Industries of India, by Norman C. Wright, M.A., D.Sc., Ph.D. Price Re. 1-8 or 2*s*. 6*d*.

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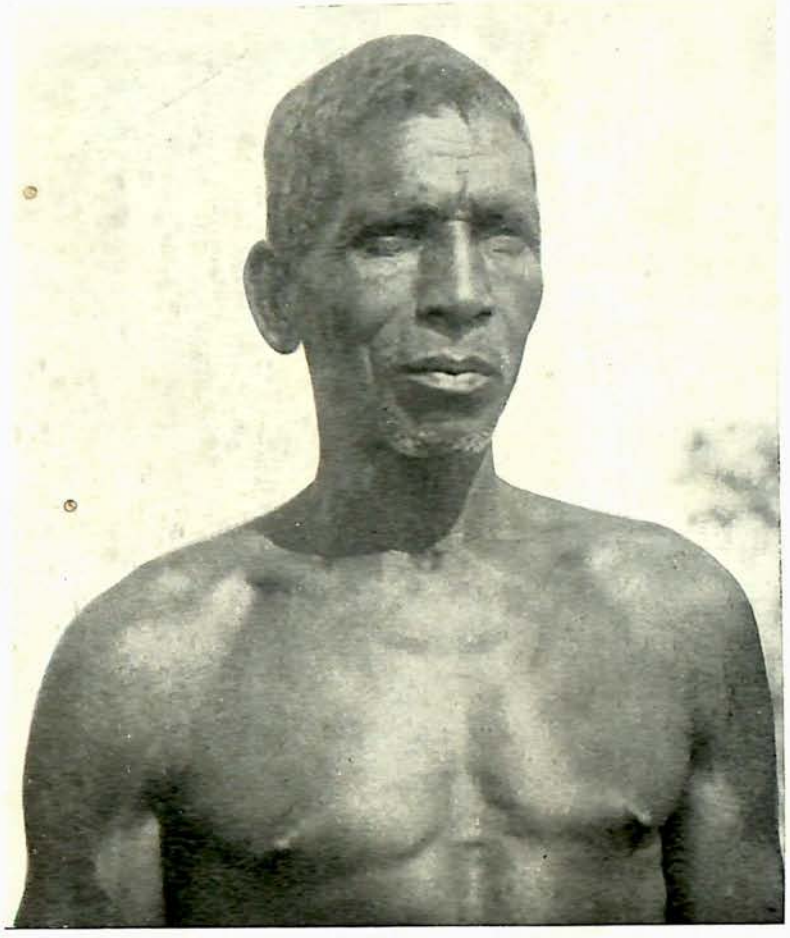

FIG. 1. A typical Hindu cultivator of Bengal

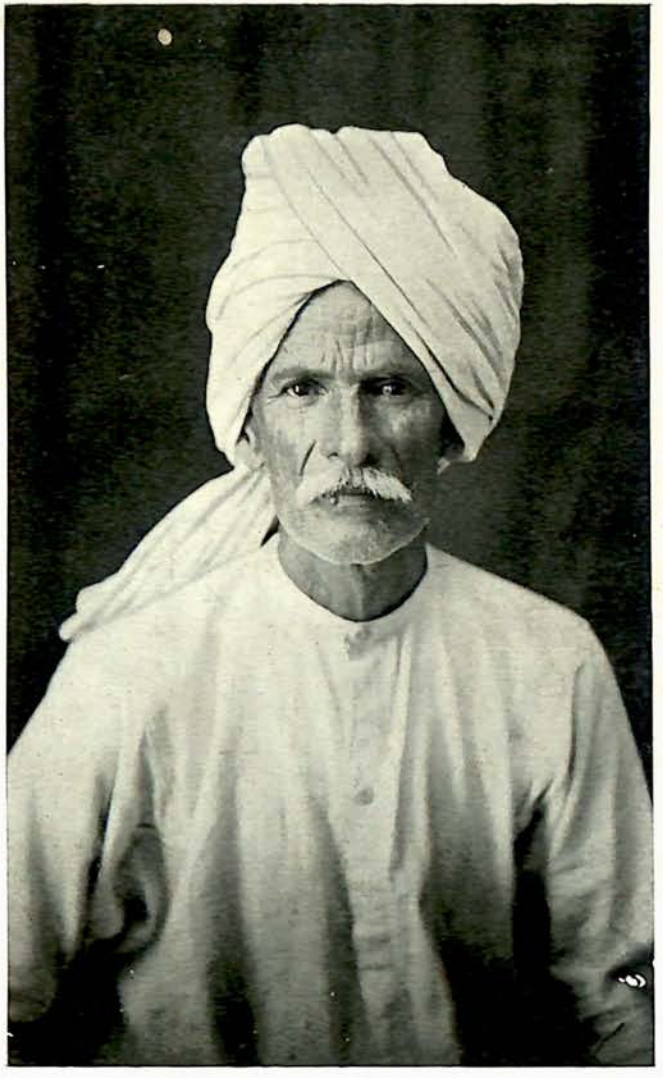

FIG. 2. A Jat of the United Provinces—A soldier cultivator

Agriculture and Animal Husbandry in India, 1936-37

CHAPTER I

AGRICULTURAL CONDITIONS DURING 1936-37

1. Agricultural and climatic conditions

An all-India generalization about the monsoon has some significance meteorologically, but not such significance agriculturally except in the case of a year of absolute failure. The 1936-37 monsoon was on the whole satisfactory, but as usual there were places where this could not be said, *e.g.*, in the Gangetic plain where there were floods and in the Bombay-Deccan and Gujarat where rain was scarce. During the main monsoon period, all-India rainfall was in excess by 4 per cent. only on the plains. During the retreating period of the monsoon, the rainfall was 8 per cent. above the normal over the same area. Taking the year as a whole, the rainfall was within 20 per cent. of the normal over most of the country.

Crop-area increases or decreases from year to year are not striking with the exception of area under sugarcane, which was 75 per cent. over the area in 1929-30. This great expansion is largely accounted for by the rapid growth of the sugar industry in India during the last few years due to the protective tariff and partly to the greater profitableness of sugarcane cultivation in comparison to other crops, there having been a progressive and substantial increase in the net production of *gur* (raw sugar). The production of wheat in India in 1935-36 was estimated at 9·4 million tons, while in 1936-37 it has been put at 9·8 million tons. The production of rice amounted to 33,197,000 tons in 1936-37 as compared to 28,211,000 tons in 1935-36. Supplies of oil-seed during 1936-37 were generally not so plentiful as in the previous year. The outturn of

groundnuts in India in 1936-37 was estimated at 2·8 million tons as compared to 2·3 million tons in the preceding year and 1·9 million tons in 1934-35. Some incentive to increase the area under linseed was provided by the larger demand from the United Kingdom for this article as a result of preference, and this, coupled with the relatively better prices secured for it, resulted in an increase in production. The linseed production was 418,000 tons in 1936-37 as against 388,000 tons in 1935-36. Jute production was 8·6 million bales in 1936-37 as against 9·6 million bales in 1935-36. Cotton production was 6,261,000 bales during the year as against 5,918,000 bales in 1935-36.

In MADRAS, the season was favourable for all crops generally at Berhampur, Anakapalle, Nandyal, Palur, Aduturai and Pattambi. The early break of the South-west monsoon combined with the hot weather rains depressed paddy yields considerably at Samalkota. At Guntur all the early crops, especially groundnut, came up well, but storms and heavy rains in October spoiled the tobacco and chilli nurseries and affected the yields of early crops. The late rains in January and February were detrimental to cotton. The South-west monsoon was a failure at Hagari. The season was quite favourable to fruit at Kodur and sugarcane at Gudiyattam, while the rainfall at Tindivanam was deficient and almost all the crops were affected there. Owing to the uneven distribution of rains at Pattukottai, dry and garden crops were affected. The season was favourable to most of the crops except pepper at Taliparamba. The season was anything but satisfactory at the Central Farm, Coimbatore. Heavy showers followed by long breaks affected the rain-fed crops which gave almost the lowest yields on record.

BOMBAY. The rainfall received was generally unevenly distributed both as regards periodicity of fall and area and it was characterised by long breaks which had an adverse effect on agricultural operations and crops. In July and August, the rainfall was markedly deficient over almost all the presidency and caused considerable anxiety in the early part of the season.

Very opportune and welcome rains in September alleviated considerably the position of agriculturists, especially in the drought-affected tracts. The season under review may be characterised as disappointing over large tracts of the presidency and it was only rainfalls received in September and November which saved many districts from almost complete failures of crops. The prolonged and unfortunate breaks in the rains resulted in considerable scarcity of fodder, grazing and drinking water in numerous centres. There was considerable migration of cattle from these tracts to more favoured localities.

BENGAL. On the whole, the season was a good one for most crops, especially jute and winter paddy, and fairly satisfactory for autumn and spring crops. The outturn of the different *bhadai* crops (grown and harvested in August to September) for the presidency was estimated at 82 per cent. of the normal this year as against 76 per cent. last year. For winter rice crops, the provincial outturn worked out at 106 per cent. of the normal as against 68 per cent. during last year. The season was fairly favourable for the *rabi* (winter or spring) crops. The outturn of different *rabi* crops for the province worked out at 84 per cent. of the normal, as against 76 per cent. last year.

PUNJAB. The season was on the whole favourable. The monsoon began early and continued strong in most districts. Rain and hail-storms of varying intensities were, however, received during March and April in many districts and caused considerable damage. The area under cotton constituted a record in the history of the province, while sugarcane fell just short of the record. In the absence of any serious damage by insect pests or fungal diseases, except in the case of the gram crop, the outturns obtained from the principal crops were unusually high. For wheat there was a considerable advance in prices on anything obtained for several years and the wheat cultivators in the province as a whole had an excellent year.

In BURMA, the abundant early rain enabled a timely start to be made in preliminary cultivation and in the putting down

of nurseries in the paddy areas. Late rains over practically the whole of the country were short, and the monsoon came to an end about the middle of October. In the paddy areas abundant rain during the first half of the season resulted in satisfactory vegetative growth. The late rains, however, were in many areas too light thoroughly to mature the grain, and early hopes of a bumper crop were not fulfilled.

In BIHAR, the untimely rains in February did a certain amount of damage to standing *rabi* crops.

CENTRAL PROVINCES AND BERAR. *Kharif* (rainy season) sowings were carried out under favourable conditions and germination was satisfactory. In spite of the vagaries of weather which resulted in damaged crops, the season was on the whole favourable for most of the *kharif* crops and excellent for groundnut which gave a heavy harvest everywhere. It was also generally favourable for rice which gave a normal harvest except where the crop suffered from the *gangai* disease. A series of cold waves, followed by frequent showers of rain and hail-storms in January, February and March favoured rust attack in linseed and wheat in the northern districts.

In ASSAM, the rainfall was rather unevenly distributed throughout the province. The season for winter rice was generally favourable in the beginning but not during the later part, while for autumn rice the season was, on the whole, fair. There was increased cultivation of rice, sugarcane, jute, rape and mustard and tea, as compared with the previous year. The yields per acre of all crops slightly increased except sugarcane and tea.

In MYSORE, the rainfall during the year was normal in most of the districts. The cotton crop suffered from Koleroga on account of continuous rainfall without a break to allow spraying.

In COCHIN, water scarcity was not so very severe as in previous years. The rainfall recorded was on the whole slightly in excess of the normal, with a proportionate increase in the number of rainy days.

2. Economic conditions

A good harvest was obtained from most of the crops during the year. The general level of commodity prices had begun to show an upward trend even before 1936. There was a sharp rise in the prices of many commodities during 1936 and the first quarter of 1937. Though a set-back occurred subsequently, this rise in the prices of agricultural commodities and raw materials was one of the noteworthy features of the year under review. Although the improvement in agricultural prices began some time previously, it was only during last year that there was a marked advance in the prices of India's agricultural products. The most striking rise has occurred in the case of tea, due to the Tea Restriction Scheme which came into operation in 1933. Prices of linseed showed the next largest recovery. The effects of the demand for primary commodities and raw materials have been influenced in the case of each agricultural commodity by the special conditions ruling in that market in India as well as in other countries. The increase in the demand for raw cotton was reflected in a great increase in India's export trade in this article. Other countries purchased from India 4·3 million bales during 1936-37 which was the highest level reached for many years and was about a million bales more than the shipments during 1935-36. Japan took 2,426,000 bales (or 667,000 bales more than in 1935-36). Indian cotton was generally in better demand in foreign markets than in the preceding year, due partly to the favourable price-parity for most of the months of the year 1936-37.

Conditions in the raw jute market deteriorated generally in the year under review and it was only towards the end of the year that some improvement became noticeable. The total exports of raw and manufactured jute during the year amounted to 1,792,000 tons as compared with 1,523,000 tons in the preceding year, an increase of 18 per cent.

Most of the oil-seeds registered substantial increases in price in 1936-37. The total exports of oil-seeds showed an increase of 72 per cent. in quantity and 79 per cent. in value.

Despite the growing internal consumption, all the principal oil-seeds, with the exception of castor, recorded increases in exports. With the rise in prices, this meant a substantially larger value. The vagaries of the Argentine and North America crops and the preference granted in the United Kingdom greatly helped the demand for Indian linseed. During 1936-37 the exports amounted to 296,000 tons out of which 217,000 tons went to the United Kingdom. In wheat there was a remarkable increase in the world prices in 1936-37. Quotations in March, 1937, recorded an improvement of one rupee a maund or 42 per cent. as compared with those of April, 1936. The rise in the world price of wheat enabled India to figure once again as a wheat exporting country. During 1936-37 exports of wheat from India amounted to 232,000 tons as against the insignificant figure of 10,000 tons in 1935-36. Internal prices of wheat in India also rose rapidly in sympathy with the upward movement of wheat prices in the world. Exports of rice and paddy from Burma amounted to 2,852,000 tons of which 1,621,000 tons were to India. Exports from India proper amounted to 235,000 tons. Exports overseas from India and Burma were valued at Rs. 11,62 lakhs. The price of rice remained comparatively steady during 1936-37 and the average price for the year was much the same as that for the preceding year.

During the year under report, the new constitution for India came into being. This involved the separation of Orissa from Bihar and of Sind from Bombay. These two new provinces have now their own representatives on the Governing Body and Advisory Board of the Imperial Council of Agricultural Research.

3. Imperial Council of Agricultural Research.

There was considerable expansion in the activities of the Council during the year under report. The Advisory Board met twice and the Governing Body met once during the year.

The annual general meeting of the Council took place in January, 1937, and the annual report on the working of the Council including the accounts for 1935-36 were adopted. An important decision was taken by the Governing Body in regard to provincial contributions to research schemes. It was decided that such contributions should be 50 per cent. of the total cost of each scheme unless there were adequate reasons to the contrary. The Council received from the Government of India a grant for expenditure on the provincial portion of the marketing scheme of Rs. 2 lakhs and a grant of Rs. 1,75,000 for sugar research in addition to the usual annual grant of Rs. 5 lakhs. The number of new schemes approved by the Governing Body during the year was 18 and the total fund allotted for research at the end of 1936-37 was Rs. 49,66,865*. Of the total number of schemes financed by the Council, 108 are under Local Departments of Agriculture, and 23 are carried out by University organisations or private bodies. A complete list of schemes financed by the Council is given in Appendix XIV.

A scientific stock-taking of the research activities of the Council was carried out by two British Experts, *viz.*, Sir John Russell and Dr. N. C. Wright. A detailed account of their visit, terms of reference and the reports is given in Chapter II.

Cost of Production of Crops in India.—The enquiry terminated in all provinces and States by about the end of November, 1936, with the exception of Bengal and Bihar where it continued till June, 1937. The data for all the three years from all the provinces have been received and are being compiled and analysed. A meeting of the Joint Sub-committee was convened at Bombay on 28th February, 1937, to decide certain controversial points and another meeting in July to decide finally the way in which the data should be presented.

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* Excludes contributions to International Bureaux of Agricultural and Veterinary Research and Indian Institute of Science, deputation of India's representatives to International Conferences and Council's Headquarters General Schemes.

During the year, the following additional States co-operated with the Central Marketing Staff in the Marketing Scheme, *viz.*, Travancore, Indore, Nabha, Bawishi and Mohanpur (Sabar Kantha Agency). The marketing survey work was carried out on the basis of a common programme in all the provinces, nine major States and in over two hundred smaller States which were dealt with by the Central Staff by means of questionnaires. A conference was held between the Central Marketing Staff and Senior Marketing Officers in the provinces and States at Delhi at the end of April, 1936. An all-India report on the marketing of wheat was published on April 27, 1937. Other reports, *e.g.*, those on cattle, linseed, tobacco and eggs, are in advanced stage of preparation. Two experimental grading stations for hides were established in the last week of November—one at Agra and the other at Delhi. An informal conference of representatives of certain leading Indian grain trade associations and mills was held at Delhi in April, 1936, with the object of exploring the possibility of eliminating existing differences between standards and contract terms in the grain markets of India. As a result of the discussion, provisional standard contract terms were agreed on.

An informal meeting with some representatives of the tanning industry was held at Cawnpore in July, 1936, to consider contract terms and the existing system of classification of hides and skins with a view to defining suitable grades for raw hides and skins for the internal market. In October, 1936, a conference was held at Guntur of representative producers, merchants and manufacturers to form a Tobacco Association in time for the 1937 season. The Agricultural Marketing Adviser attended a meeting of the Sugar Mills Association in Calcutta in August, 1936, and of the Western Indian Cattle Dealers' Association in January, 1937, to discuss certain difficulties in regard to the movement of cattle.

In March, 1937, he met the Calcutta Hides and Skins Shippers' Association when it was agreed that the members of the Association would instruct their agents to buy on a grade

basis (instead of the customary flat rate) hides which were graded and marked in accordance with the statutory rules.

During the year under report, the British Commonwealth Scientific Conference assembled in London in September, 1936. The participation in the Conference was of particular significance to the Imperial Council of Agricultural Research which makes a substantial contribution towards the finances of the Imperial Agricultural Bureaux and allied institutes—a subject of prominent interest to the Conference. The Conference placed on record their considered views regarding the work and the usefulness of the Bureaux as affording an example of effective co-operation in a true intra-Imperial basis. The Conference provided valuable opportunities to the representatives of India for making and renewing valuable contacts with those engaged in similar work throughout the Commonwealth.

Amongst the miscellaneous activities of the Council during the year may be mentioned co-operation with the Imperial Bureaux. To effect greater co-operation with the Imperial Bureaux of Plant Genetics for Herbage Plants, the Imperial Council of Agricultural Research arranged for the supply of certain seed samples of *Lolium* species to the Welsh Plant Breeding Station, and the Imperial Agriculturist, Imperial Agricultural Research Institute, New Delhi, contributed an article on the berseem cultivation in India for inclusion in the Bulletin on the Production of Seed of Herbage and Forage Crops to be issued by the Bureau.

Some information on the subject of biennial bearing in mangoes in different parts of India was also collected and transmitted to the Imperial Bureau of Fruit Production, East Malling.

The Fourth International Grassland Congress was held from 8th to 23rd July, 1937, at Aberystwyth, North Wales, and an official invitation from the English Ministry of Agriculture and Fisheries inviting the Government of India to participate in the Congress was received from the India Office. Provincial Governments were consulted and four delegates attended.

The Imperial Council of Agricultural Research was responsible for sending from India Prof. L. S. S. Kumar, Economic Botanist to the Bombay Government.

The Sixth Commission of the International Society of Soil Science held its meeting at Zurich (Switzerland) in August, 1937. On an enquiry from the Provincial Governments it was agreed that Mr. S. T. H. Munsey, I.S.E., a representative of the United Provinces Government, should attend the meeting on their behalf.

The Fourth International Locust Conference met in April, 1936, at Cairo in response to an invitation by the Egyptian Government to various countries interested in locust research. It was attended by sixty-three delegates representing twenty-five countries. India was represented by Khan Bahadur M. Afzal Husain, M.A. (Cantab.), I.A.S., Punjab Government Entomologist, who read two papers at the Conference, *viz.*, (i) Migration among the Solitaries and (ii) The Occurrence of Incipient Swarming in Mekran. The second paper was contributed by the Locust Research Entomologist, Karachi. The discussions, which took place at the Conference, are reported to have been of great interest in regard to locust research and control.

The 13th General Assembly of the International Institute of Agriculture, Rome, was held in October, 1936, and India was represented thereat by Mr. B. Rama Rau, Deputy High Commissioner for India, and Mr. S. R. Zaman, Secretary, Public Department, Office of the High Commissioner for India, London. As in previous years, the High Commissioner represented India on the Permanent Committee of the International Institute of Agriculture, Rome.

Amongst activities in India may be mentioned the second meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry, which was held in Madras in December, 1936, by invitation of the Government of Madras. His Excellency Lord Erskine, Governor of Madras, opened the Conference and attended the first session. Sir John Russell

and Dr. N. C. Wright both attended the meeting. The discussion embraced several important matters, including measures to give effect to His Excellency the Viceroy's cattle improvement scheme.

The Sugar Committee met at Simla in July, 1936. Sir William Stampe, Kt., C.I.E., Chief Engineer to the Government of the United Provinces, gave an instructive address on hydro-electric developments and the use of underground water supplies in the United Provinces with special reference to sugarcane cultivation. The Sugar Committee considered the views of the Departments of Agriculture in the provinces and constituent Indian States and of factory owners on the relative advantages and disadvantages of ratooning. This resulted in the appointment of a special technical sub-committee to work out details of an experimental scheme in order to get accurate information as to the effect of ratooning on the incidence of insect pests. There was an important discussion on the recommendations of the Crop Planning Conference regarding extension of sugarcane cultivation.

The first meeting of the Standing Committee on Rice, which was constituted in 1936, was held in January, 1937. Interesting notes were sent up by several Provincial Departments of Agriculture and by individual members of the Committee on various aspects of the production, marketing and general improvement of the rice crop.

A meeting of the Standing Committee on Wheat was held at Simla in July, 1936.

During the year under report, two small sub-committees were appointed—one for cotton and the other for rice—to arrange for the collection of information regarding the range of variability in all characters which it is proposed to measure and in this work to include the designing of schedules for acceptance by the Advisory Board and for use throughout India by botanical workers when describing these crops. The first committee met in Bombay in March, 1937, and the second in May,

1937, at the Imperial Agricultural Research Institute, New Delhi. The reports of the Committees will fall within the purview of the next Review.

Rural Development Grants.—Throughout the report references occur to the special grants made to provinces by the Central Government from the Rural Development Fund created in 1935, when approximately Rs. 2·8 crores were set aside for this purpose. With the aid of these grants much additional demonstration and development work was initiated for the improvement of crop production and animal husbandry.

CHAPTER II

THE VISIT OF SIR JOHN RUSSELL AND DR. N. C. WRIGHT TO INDIA.

1. Sir John Russell's Report. The Imperial Council of Agricultural Research was established in the year 1929. One of the conditions laid down for it by the Royal Commission on Agriculture of 1926 was that its work should periodically be reviewed by some disinterested expert. In the year 1936-37, Sir John Russell, D.Sc., F.R.S., Director of the Rothamsted Experimental Station, and Dr. N. C. Wright, M.A., D.Sc., Ph.D., Director of the Hannah Dairy Institute, Ayrshire, were invited to carry out the first review of this kind. The ground was carefully prepared for them in advance and for each of these experts a ' Brief ' was prepared which reviewed the work in the one case on crops and soils and in the other on dairying, and with this as a basis and with the assistance in each case of a Secretary-Adviser belonging to the Indian Agricultural Service and Punjab Veterinary Service respectively, the two experts toured India in the cold weather of 1936-37. Sir John Russell landed in India on November 4, 1936, and left on March 25, 1937. His report was released in India in September, 1937 and its far-reaching recommendations have been under study by appropriate individuals and institutions since then.

Sir John's report is divided into two main parts and is concluded by a " Summary and Recommendations ". The first part gives a historical survey, a useful chapter on the stages in agricultural improvement, a chapter on the crops of India, also chapters on factors improving the yields of crops and on special difficulties concerning Indian agriculture, the machinery for dealing with these problems and a chapter devoted to the

Imperial Agricultural Research Institute at New Delhi. The second part deals with all the schemes in detail; these are grouped according to the province or State within which they are located.

Sir John insists that the most important and most difficult task before agricultural officers in India is to bridge the gulf separating the agricultural experiment stations from the peasants. Fuller use of existing science is needed and it is recommended that the Council should immediately enquire how this can best be done. Sir John Russell himself makes certain helpful suggestions. He emphasises the need for workers in experimental stations always to repeat in simplified form their experiments on cultivators' fields in the neighbourhood and he mentions in more than one place the desirability of taking a complete holding and not merely a plot where it is desirable to try out a new method.

On the subject of the study of insect pests, Sir John Russell has a new and illuminating view-point. He considers that the really important thing is not so much now the working out of the life-histories of insect pests, but the survey in the field; of how they increase and decrease and particularly of the conditions which are favourable or unfavourable to them. It may then be possible to work out changes in cultivation methods that will enable the crop to escape a pest or will reduce the pest to such proportions that it is really negligible.

Sir John Russell is himself essentially a soil scientist and his remarks concerning the group of dry-farming research schemes are peculiarly helpful. So also are his comments and criticisms on manurial experiments for all crops, in which case he insists on the need for replanning many of these on more uniform lines with clearer aims.

In Recommendation 3, emphasis is laid on the need for work on cash crops to be done in association with the expert buyers or users of these crops. Recommendation 4, which deals with work on crops mainly retained for food in the country,

emphasises the need for this work being done in association with nutrition experts. Sir John envisages, as a result of increased productiveness due to the growing of better yielding strains, the liberation of land for supplementary crops and for fodder. This result is again intimately connected with nutrition since, among these supplementary crops, he hopes to see a great increase in fruits and vegetables, particularly the green leaf vegetables, while the putting of more land under fodder means a bigger and better milk supply. Sir John Russell recommends the subsidising of university workers but recommends that such grants shall be essentially personal.

Sir John Russell also recommends (Recommendation 7) the setting up of a Soil Conservation Committee to collect the results of manurial trials, to watch regions liable to erosion and to work out schemes in connection with them and for various other purposes. He recommends the establishment of a Crop Protection Committee (Recommendation 9) with very extensive terms of reference to deal with the consideration of cropping schemes much on the lines adopted by the Crop Planning Conference, the general oversight of the programme of research work on crops, the organisation of watching services to report on the incidence of insect and fungus pests, noxious weeds or other enemies of crop production and to arrange for the working out of control measures.

Sir John recommends that the machinery at the disposal of the Council for carrying out its work should consist of :—

(*a*) the Imperial Agricultural Research Institute, New Delhi, which should work in close co-operation with the Council and whose programme would be largely dependent upon problems concerning the Council,

(*b*) a marketing branch,

(*c*) a cadre of approved investigators and

(*d*) a staff of temporary investigators.

His last recommendation deals with funds and runs as follows :—

> " These recommendations, if carried into effect, will necessitate an increased grant to the Council. I, however, see no other alternative to the acceptance of this suggestion. The Council is the co-ordinating agency which provides invaluable assistance to the provincial Agricultural Departments and will afford still greater help if it is given the wider developmental powers that will enable it to bring to fruition investigations which at present stop at the experimental stage."

Sir John's report is likely to be an important factor in the future development of agricultural research and extension work in India.

2. Dr. N. C. Wright's Report. Following as it did closely on the Viceroy's appeal for more attention to be paid to live-stock improvement in this country, Dr. Wright's visit intensified the interest in Indian cattle already aroused by His Excellency and tended to accelerate the movement initiated by him. He was invited by the Imperial Council of Agricultural Research to advise on

(i) the lines to be followed to secure (*a*) increased and more economical production and (*b*) improved collection, handling and disposal of milk and milk products,

(ii) the lines of research required to be taken up in relation to (*a*) the composition and physical properties of the various milks available in India, (*b*) the industrial processing of such milks, and (*c*) the manufacture of by-products,

(iii) facilities which should be provided by Government for testing new plants and machinery, in order to take advantage of recent advances in dairy science,

(iv) what additional technical and scientific staff and facilities are required for the above purposes,

(v) the policy to be followed regarding research schemes now in operation and

(vi) what further steps, than those which exist at present, are desirable for more extensive and speedier dissemination of scientific and technical information, not only in regard to research but also in regard to animal husbandry matters in general with special reference to dairy science.

Dr. Wright arrived in India at the end of October, 1936, and after studying the conditions here returned at the end of March, 1937, and subsequently submitted his report from England. His report is divided into three parts. Parts I and II contain the results of a detailed examination of the present position in regard to the production and handling of milk and the breeding and nutrition of milch cattle, and amongst other facts brought to light, the report points out that while India produces annually between 700 and 800 million maunds of milk, which makes her the second largest milk-producing country in the world, the average daily *per capita* consumption of milk and milk products is the equivalent of 7 to 8 ozs. of milk only. The normal requirement for maintenance of satisfactory health is not less than 15 ozs., so that production should be at least doubled and in order that this important food may be brought within the reach of everyone the cost of production and distribution of milk and milk products must be reduced considerably.

Only a third of the total consumption is in the form of liquid milk, $\frac{1}{2}$ in the form of ghee and the remaining $\frac{1}{6}$ in the form mainly of indigenous products like *khoa* (desiccated milk), *dahi* (curd), etc. Any development of the dairy industry should therefore be directed towards improvement in the production and marketing of indigenous products, particularly ghee.

India possesses about a third of the total world's cattle population of 690 million animals. Though their productive value is incommensurate with their numbers their actual and potential value is immense. Milk and milk products may be valued at 300 crores of rupees annually, hides and skins at 40 crores, cattle labour at 300 to 500 crores and manure at about 270 crores. The total annual value of India's live-stock industry is, therefore, estimated at over 1,000 crores of rupees.

In Part III of the report Dr. Wright makes his recommendations which may be summarized as follows :—

(1) *Development of Dairy Research, Education and Advisory Services.*

To provide an adequately staffed and equipped centre for research into the many problems which face the Indian Dairy Industry, the existing Institute at Bangalore should be transferred to a more suitable central site and reconstituted as an Imperial Dairy Research Institute with four sections to deal with Dairy Bacteriology, Dairy Chemistry, Dairy Technology and Dairy Husbandry. If such an Institute is established, it is pointed out that the need for a separate experimental creamery will not arise but the Anand Creamery might be utilised as a sub-station for investigating special problems relating to the supply of milk to large cities. Side by side with the development of such a Central Institute, investigation of dairy problems at provincial Agricultural Colleges should be encouraged, with the assistance of the Imperial Council of Agricultural Research, and the point is stressed that many of the problems requiring the most urgent attention are comparatively elementary ones connected with the hygienic production, handling and distribution of milk and its indigenous products.

Though certain alterations in the existing syllabus for the I.D.D. are essential, extension of the course to three years is unnecessary. In the syllabus stress should be laid on the

methods of production of indigenous milk products, devising of cheap types of equipment and methods of producing milk and milk products by co-operative enterprise. The course should also include practical training in methods of imparting instruction.

Training for the I.D.D. should be given in provincial colleges and not at the Central Institute. A special committee should be set up by the Imperial Council of Agricultural Research for working out the details of the course of training so as to ensure uniformity.

As regards post-graduate training, the N.D.D. of Great Britain is unsuitable for Indian students. For training in research methods facilities should be provided at the Central Institute and the Imperial Council of Agricultural Research should give scholarships to such graduates as wish to gain further experience in laboratories abroad.

Provincial Governments should establish an advisory service for the Dairy Industry. As a first step, a Dairy Development Officer should be appointed in each province. He should work under a Committee representative of the various branches of Government activity concerned.

(2) *Development of Research, Education and Advisory Services in connection with Cattle Improvement.*

The solution of problems connected with breeding requires the appointment of an Animal Geneticist, who will investigate problems relating to the physiology of reproduction (including endocrinology), management and constitution. Greater use should be made of existing experimental and demonstration farms (of which there are 200 at present) in studying problems of fodder production. Such farms should be equipped with small herds of pedigree milch cattle. They would then fulfil a dual function by acting as centres for the study of " mixed-farming " methods and by providing valuable nuclei for the breeding and distribution of pedigree milking stock.

Use should be made of Lyallpur, Dacca, Coimbatore and Izatnagar for devising suitable rations for Indian cattle and buffaloes and the allocation of work between these different centres is suggested.

As regards deficiency diseases, Veterinary Investigation Officers should be responsible for field surveys and Izatnagar for the mineral analysis of suspected pastures. Each Veterinary College should have a small herd of milking cows, with accompanying young stock and sufficient land for instruction in breeding and live-stock management. The Imperial Council of Agricultural Research should give scholarships to enable promising post-graduates to secure advanced training abroad in genetical research. A small number of trained geneticists will be required in connection with the establishment of an Animal Genetics Section at Izatnagar.

Elementary courses of instruction should be provided for " stockmen " who will be required to work among cultivators for the effective dissemination of knowledge regarding dairying and general live-stock improvement.

Live-stock improvement and veterinary work should be unified under a single Department of Animal Husbandry. The Director of such a unified Department should have in his staff a Live-stock Expert who should work in close touch with Fodder Specialist in the Agricultural Department.

Every effort should be made to augment the number of agencies which can be used for developing the milking potentialities of Indian cattle. These should include Military Dairy Farms, Demonstration Farms, *gowshalas* and *pinjrapoles*. A special officer should be appointed under the Imperial Council of Agricultural Research, whose duties would include stimulation of interest in milch cattle breeding at various centres and the imparting of expert advice to *gowshalas* and *pinjrapoles* which desire to improve their methods of management and to adopt a constructive breeding policy.

To maintain close co-operation between all departments concerned with rural development, a Board of Rural Development under the chairmanship of a non-technical officer of the rank of a Commissioner should be constituted in each province. This Board should include Directors of Agriculture, Veterinary Services, Forestry and Public Health and representatives of the Irrigation, Revenue and Co-operative Departments. This Board would act solely as a co-ordinating and advisory body to the Minister responsible for the development of agriculture in the province.

CHAPTER III

ECONOMIC WORK ON CROPS*

THE ascertained area under improved varieties of crops in British India in 1936-37 was approximately 23·9 million acres, as compared with 21·4 million acres in 1935-36. In other words, the recorded area under improved crops has increased by 12 per cent. during the period under review. These figures by no means represent the whole extent to which improved strains have replaced old varieties as it is almost an impossible task to gauge the full extent of the natural spread of improved

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(2) Dr. B. P. Pal, M.Sc., Ph.D. (Cantab.), F.L.S., Imperial Economic Botanist, Imperial Agricultural Research Institute, New Delhi . . . . . *Wheat, Tobacco and Potatoes.*

(3) Mr. D. N. Mahta, B.A. (Oxon.), F.L.S., Secretary, Indian Central Cotton Committee, Bombay . . *Cotton.*

(4) Mr. R. C. Srivastava, B.Sc., O.B.E., Director, Imperial Institute of Sugar Technology, Cawnpore . *Sugarcane.*

(5) Mr. A. P. Cliff, B.A., Dip. Agri. (Cantab.), I.A.S., Secretary, Indian Central Jute Committee, Calcutta *Jute.*

(6) Dr. J. S. Patel, B.Sc. (Agri.), M.Sc. (Cornell.), Ph.D. (Edin.), Oil-seeds Specialist, Coimbatore . . *Oil-seeds.*

(7) Mr. P. H. Carpenter, F.I.C., Chief Scientific Officer, Indian Tea Association, Tocklai Experiment Station, Cinnamara P. O., Assam . . . . *Tea.*

(8) Dr. W. S. Shaw, D.Sc., Ph.D., M.Sc., F.I.C., Scientific Officer, U. P. A. S. I. Tea Experiment Station, Devarshola P. O., Nilgiris . . . . . *Coffee.*

(9) Mr. B. S. Sawhney, B.A. (Cantab.), Botanist for Millets, Botanical Sub-station, Sirsa, Punjab . . *Millets, Pulses and Beans.*

(10) Rao Sahib Ram Dhan Singh, L.Ag., B.Sc., Dip. Agri. (Cantab.), Cereal Specialist, Punjab Agricultural College, Lyallpur . . . . . *Other Cereals,*

varieties. Tables I and II show the position so far as it can be ascertained :—

TABLE I

Areas under improved crops in India during 1936-37 (in acres), so far as information is available

Province or State	Rice	Cotton	Wheat	Jute	Sugarcane	Other crops
			British India			
Madras	1,395,043	602,739	..	..	49,516	99,007
Bombay	21,495	613,409	50,367	..	18,539	88,825
Bengal	776,284	..	..	1,301,444	327,816	64,319
United Provinces	..	445,000	2,873,000	..	1,973,500	621,700
Punjab	..	2,228,200	4,260,900	..	302,600	..
Bihar	42,554	..	58,350	300	473,524	14,361
Central Provinces and Berar.	667,733	476,923	649,687	..	..	400,464
Assam	52,498	..	..	13,765	17,551	8,892
North-West Frontier Province.	..	1,412	134,519	..	2,510	37,640
Orissa	21,709	86	410	260	31,000	24,310
Sind	342,355	496,437	301,664	..	..	147,169
Baluchistan	..	..	000	..	..	..
Burma*	1,143,763	5,980	19,340	..	31,165	359,497
TOTAL FOR BRITISH INDIA AND BURMA.	4,463,434	4,870,186	8,349,137	1,315,769	3,227,721	1,866,184
			Indian States			
Hyderabad	1,543	107,072	1,380	..	9,151	128,197
Mysore	109,204	21,988	1	..	30,514	299,850
Baroda	6,749	59,694	12,245	..	100	131
Travancore	304	..	..	..	..	..
Cochin	405	5,200	..	..	75	142
Bhopal	10	47	62,196	..	..	5,787
Gwalior	347	16,306	58,224	..	4,069	106,982
Kashmir	9,707	..	15,370	..	2,510	37,127
TOTAL FOR INDIAN STATES.	128,269	210,307	149,416	..	46,419	578,216
GRAND TOTAL FOR BRITISH INDIA AND INDIAN STATES.	4,591,703	5,080,493	8,498,553	1,315,769	3,274,140	2,444,400

* Burma formed part of British India up to 31st March, 1937.

TABLE II

Areas under improved crops in India (so far as information is available)

Crops	British India and Burma		Indian States		Grand Total for British India and Indian States	
	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37
Cotton	4,899,129	4,870,186	150,803	210,307	5,059,932	5,080,493
Wheat	6,922,835	8,349,137	48,020	149,416	6,970,855	8,498,553
Rice	3,575,644	4,463,434	93,453	128,269	3,669,097	4,591,703
Sugarcane	3,203,306	3,227,721	41,030	46,419	3,244,336	3,274,140
Jute	1,121,019	1,315,769	..	..	1,121,019	1,315,769
Groundnut	186,045	194,271	65,729	147,258	251,774	341,529
Millets	338,787	234,956	341,540	318,802	680,277	553,758
Gram	331,923	338,892	502	5,909	332,425	344,801
Potatoes	8,742	12,117	525	603	9,297	12,720
Other crops	818,518	983,638	26,138	105,644	844,651	1,089,282
TOTAL	21,405,893	23,990,121	777,740	1,112,627	22,183,633	25,102,748

1. Rice

THE rice crop occupies, on an average, about 35 per cent. of the total cultivated area in India and Burma. Table III shows the estimated area and production of rice during the year under review and the preceding four seasons :—

TABLE III

Acreage and production of rice during the five years from 1932-33 to 1936-37 (including Burma)

Year	Area in acres (thousands)	Yields in tons (thousands)
1932-33	82,882	31,114
1933-34	83,423	30,907
1934-35	82,507	30,238
1935-36	83,508	28,211
1936-37	84,420	33,197

It will be seen that there is an increase of one per cent. in area over that of the last season and an increase in production by 17·7 per cent.

The price of rice in general remained comparatively steady throughout the year, the average price being more or less the same as that for the preceding year. The increased internal demand in Burma kept the prices of rice remarkably steady. The very short rice crop in India proper during 1935-36 and the increased wheat prices helped to maintain the demand for Burma rice. The larger Indian crop of the year, however, led to a fall in prices during the first quarter of 1937.

In Table IV are shown production and export of rice in India proper and Burma for the past five years together with the corresponding figures for the pre-War year, 1913-14.

TABLE IV

Production and export of rice in India proper and Burma during 1932-33 to 1936-37 and 1913-14

Year	Production in tons (thousands)		Exports in tons (thousands)			
			Rice		Paddy	
	India proper	Burma	India proper	Burma	India proper	Burma
1913-14	24,782	4,037	585	1,835	10	20
1932-33	26,201	4,913	226	1,602	4	55
1933-34	25,733	5,174	216	1,517	1	10
1934-35	25,706	4,532	204	1,389	4	10
1935-36	23,213	4,998	189	1,205	4	12
1936-37	28,488	4,709	234	1,223	1	7

The estimated outturn of rice was nearly five million tons more in 1936-37 than that of the preceding year in India proper. Burma, however, showed a decline in production, in spite of the increased area under rice during the present year as compared with that of 1935-36. Compared to the year 1913-14, both the countries show increased area and production.

During the year under consideration, Burma exported about 1,621,000 tons of rice (including paddy) to India. India and Burma together exported 1,466,000 tons of rice, including negligible quantities of paddy in 1936-37, Burma's share being 84 per cent and that of Bengal and Madras 8 and 6 per cent respectively.

The IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH continued to promote and finance a large number of schemes for the genetic improvement and investigation of ancillary problems of rice in various rice-growing provinces. The outstanding events concerning rice and the investigations during the year on the rice crop and plant are briefly summarized below :—

The Standing Committee on Rice, appointed last year, held its first meeting at New Delhi on 22nd and 23rd January, 1937. The Committee emphasized the necessity of more accurate determination of the area under rice in permanently settled provinces and better determination of the standard yields in all provinces. For this purpose, properly randomized sampling surveys and adequate crop-cutting experiments on modern lines were recommended. Another important recommendation the Committee made was the standardization of methods of describing variability in rice. For this purpose a small committee of rice-breeders was appointed. *Inter alia* marketing of rice and paddy, co-ordination of fertilizer experiments, various progress reports, technical programmes and new schemes were also discussed.

For the marketing surveys, initiated last year, over 2,350 samples of paddy and rice were subjected to physical examination by the various crop-botanists in different provinces. Of these, 765 samples were tested for cooking behaviour at Dacca and Coimbatore.

Sir John Russell in his report has commended and approved the plant breeding and general lines of rice work in progress under the auspices of the Imperial Council of Agricultural Research. He has pointed out the greater need for more work on water-requirements of new varieties of paddy in different

environmental conditions and the manurial experiments to include nitrogenous and phosphatic fertilisers alone and in combination with green manure.

A brief summary of the work in different provinces is given below :—

BENGAL. The estimated area for the year was 21,993,000 acres and production 10,668,000 tons, showing increase of 901,000 acres and 3,460,000 tons in production over those of the last year. The considerable increase in yield is due to all-round favourable season during the current year.

Dacca is the chief centre of research. As usual, a very large number of pure lines of various kinds of rices were maintained and further augmented at this station. Among the early *amans* (winter paddy), Jesho-balam gave the highest yield and among the mid-late and the late strains Latisail (S. 22) was the most prolific. A synthetic strain (8/301), from a cross between Jhingasail and Latisail, has given better yield than the parents. Cytological studies on *O. coarctata* showed it to possess $2n=44$ chromosomes. The deep-water paddy strain No. 1 (6) continued to do well in Rajabazar *beel* area in the Dacca district. For the Satmajid area, where the water-level rises up to 14-15 feet, Maitachang-834 and Kala-aman-809 have proved better than Kala-aman-817 and Lota-aman-792. The first two strains are being multiplied for distribution.

An experiment to determine the effect of Paris green on the yield of rice was carried out during the year with the mid-late Dacca No. 1 (Indrasail) variety. Paris green diluted to 2 per cent strength was dusted at the rate of 50 lbs. per acre in the morning and in the evening. The 2 per cent strength of the chemical was sufficient to reduce the yield of rice by about 20 per cent, irrespective of the time of dusting. The yield of straw, however, was not affected.

The Agricultural Chemist to Government, Bengal, studied in pot cultures the response of Kataktara variety to different doses of phosphorus, potash and magnesium with equal amount of nitrogen in each. Phosphorus showed significant increase

over control, whereas the other two fertilizers did not show any significant effects.

At the Chinsurah station 1,383 pure-lines of rice have been established. In preliminary and field trials, Jhanji-34 proved superior to the local Kele variety. Correlation studies with nineteen *aman* varieties showed that the yield of grain is significantly associated with the weight of straw, number of tillers and total number of spikelets.

In a factorial experiment, involving three varieties (Nehara, Bhasamanik and Bhasakalma), five dates of planting (July 16, Aug. 1 and 16, and Sept. 1 and 16) and three spacings (6″, 9″ and 12″), all the main effects were highly significant, closer spacing and earlier planting showing better results. Among the interactions, that between the time of planting and variety alone was significant. Bhasamanik and Bhasakalma were also compared at five dates of plantings (July 14, 29, Aug. 13, 28, and Sept. 12) with five ages of seedlings (3, 5, 7, 9 and 11 weeks). Here the cultural effects were significant, the two varieties responding almost equally. The date of planting interacted significantly with the varieties and with the age of seedlings; older seedlings and earlier plantings showing better results. The crop of a late variety mixed with an early variety in the proportion of 1:3 yielded significantly less than the unmixed crop of the late variety.

The collection of pure-lines was further increased to 725 during the year at the Bankura station. Experiments to determine the suitability of various groups of strains were continued at different places. Sada-aus variety proved best in higher areas and Sundarsail in lower regions. None of the strains, however, proved better than the standard varieties for the lowest situation. About half a dozen crosses between important varieties were also under observation. Pusa strains, T 18, T 24, T 31 and T 52, proved inferior in yield to local strains.

The three cultural experiments were continued on the same lines as those of the last year. Dibbling at 9″ apart gave

significantly higher yields than transplanting of twenty-one days' old seedlings and was also better in yield than broadcasting and transplanting of twenty-eight days' old seedlings. In another experiment involving Jhingasail with different number of seedlings (1, 2, 3, 4 and 5) per hole at different times of planting (July 26, Aug. 15, Sept. 4, 24 and Oct. 14), earlier plantings were successively better than the late ones, but the yield of different number of seedlings per hole was more or less the same. These results are in accord with those obtained during the last year. The results of Bhasamanik variety at various times of planting (July 16, 30, Aug. 13, 27 and Sept. 10) with seedlings of 14, 21, 28, 35 and 42 days' old confirmed last year's findings that the earlier plantings and older seedlings gave better yields and that the time of planting influences the yield significantly.

BIHAR. During the year, the area under rice was 9,949,000 acres and the production 3,359,000 tons, showing an increase of three per cent and more than thirty-four per cent respectively over the previous year. The increased yield was due to well-distributed and ample rainfall.

The collection of rice samples at Sabour now numbers about 2,000 which represents three main groups of rices :—(1) *aus* or autumn, (2) *aman* or winter and (3) *dalua* or summer. Among the *aus*, there are four sub-groups of paddies :—(*a*) Bhadoi, (*b*) Ghora, (*c*) Beali and (*d*) Laghu. The first is being mainly dealt with at Sabour; while the Kanke sub-station, in Chota Nagpur, largely deals with Ghora paddies. Among the *amans*, there are three main groups :—(*a*) early, (*b*) mid-late and (*c*) late. Over 2,300 cultures of *amans* were studied during the year. Out of these, an early 115B, mid-late 16BK and 88BK and a late 36BK have been found considerably higher yielding than the early Dahia, mid-late Kanky-II and late Latisail local varieties.

Forty-five pure strains of *dalua* paddies have been finally obtained. Some of the selections are outstanding and are likely

to replace the local summer varieties. Their capacity to withstand flood and drought is being examined by subjecting important varieties to artificial conditions of flood and drought.

Experiments on growing *aus* and *aman* at different periods indicated that as the period of planting advances, the modal hour of blooming is shifted from morning towards late forenoon. Temperature and humidity are considered to be having greater influence on the mode of blooming than varietal differences. Exposure of plants to various day-lengths (3, 6, 9 and 11 hours, normal 12-13 hours) showed that 3 and 6 hours of sun-light produces feeble and abnormal growth. Plants with 9 and 11 hours' treatments flowered much earlier—27 to 28 days—than the normally exposed plants. In all the cases of lower exposures tillering and yields were lower than the control plants. Studies in natural cross-pollination showed that the amount varied from 0·1 to 0·4 per cent and that distance did not play any part in determining the extent of vicinism.

A number of pure-lines of *aus* and of early, mid-late and late *amans* were sown and transplanted at different dates to study the time of flowering. The observations more or less confirm previous year's findings that *aus* varieties require a definite period of growth and that the time of sowing and transplanting influences their flowering, whereas among the *amans*, time of flowering is hardly affected by changes in the period of sowing or transplanting.

Studies of the influence of various proportions of sand on the growth of rice plant showed that as the proportion of sand increases, tillering and yield tend to decrease, ninety per cent of clay with 10 per cent. of sand giving the best results.

Experiments with four ages of seedlings (3, 4, 5 and 6 weeks) planted at three different dates (25th July, 8th and 22nd of August) showed no significant results of either primary effects or of interaction between them. Earlier plantings, however, tended to give more yield. The practice of *nigar* (draining off of the fields for about a fortnight at a certain stage

of the crop) again showed no advantage over the other treatments, *e.g.*, " continuous standing water ", " water supplied as necessary " and " change of water at every fortnight ". Saturated soil conditions were found best as against standing water at $\frac{1}{2}''$ and $6''$.

In manurial trials conducted for five years, sulphate of ammonia gave better results than other artificials. Addition of superphosphate is found to be more beneficial during drought. In another experiment designed to find the best combination of nitrogen and phosphoric acid, it was found that increased doses of nitrogen (20, 40, 60 lbs.) increased the yield significantly, whereas no appreciable effects were observed when the phosphoric acid was supplied in the same quantities. The combination of sixty lbs. of nitrogen and sixty lbs. of phosphoric acid per acre showed the best results. The separate application of Ammophos and farmyard manure to seed-beds at the rate of 200 lbs. and 150 maunds per acre respectively showed no appreciable differences in yield as compared to those of the plots which received the two manures at the rate of 120 lbs. and 100 maunds. The results are contrary to those of the last year when it was found that the application of Ammophos applied in field was the best. The results of experiments of comparison of green manure with farmyard manure (each in conjunction with superphosphate) were in favour of the former. Two weeks after transplanting was found to be the best time for the application of manures.

Investigations on the mineral and water-requirements of various classes of paddy showed ammonium salts giving better results than nitrate salts. The combination of potassium nitrate with ammonium sulphate, however, gave the highest yield. The best time of application of the mixture was found to be thirty days after transplanting for both early and late varieties. Pre-treated seeds in salt solutions made better growth under saline conditions than untreated seed.

Water-requirement studies on early and late strains at various stages of growth indicated an increasing need of water

up to the flowering period, the necessity decreasing rapidly afterwards. The local varieties of early, mid-late and late *amans* showed considerably higher requirements of water than drought and flood-resistant strains from the late varieties. It was also found that the application of farmyard manure and inorganic manures lessened the requirement of water.

Dormancy and viability studies on *aman* and *dalua* varieties showed that up to 345 days after the harvest, seeds germinate to the extent of about 90 per cent, thereafter viability decreasing rapidly approaching almost to *nil* at 585 days. Storage of seeds with dehydrating agents such as calcium chloride or sulphuric acid in air-tight containers prolonged the life of seeds. Seeds stored under such conditions have been found to possess very low moisture percentage (3·6), and this is probably the reason of their maintaining germination capacity for a longer period.

ORISSA. During the year the area under rice was 5,263,000 acres and the production was 1,652,000 tons. The area was slightly less, while the production was more than twenty-seven per cent over the production of the preceding year. This increased yield has been the result of sufficient and well-distributed rainfall. With the separation of the province from Bihar, the Station at Cuttack has now become the main station of the province.

Work on Beali and Laghu groups of the *aus* types has been in progress at the Cuttack Farm and about half a dozen improved types have been obtained from these two groups. The work on selection of varieties which can resist the saline condition and flood is also in progress.

BURMA. During the year the area under rice was 12,691,000 acres representing nearly 15 per cent of the total acreage in India. Although the estimated acreage shows an increase of about one-and-a-half per cent over that of the preceding year, the production has declined by nearly 6 per cent, being 4,709,000 tons or slightly over 14 per cent of the total production in India.

Over 200 hybrid cultures involving local and foreign varieties were under examination in various generations at Hmawbi. From a cross between two local rices, two highly prolific strains (Xa-97 and Xa-108) have been produced. These are suitable for Southern and Irrawaddy circles. Siamese rices have proved more suitable than other foreign varieties. Some Australian varieties were also collected during the season.

The genetical investigations have again shown that full and partial sterility is multi-genic in inheritance. In one cross, " shortness " of grain tended to be dominant over " lengthiness ", but there was no clear-cut segregation in later generations. Contrary results were obtained with regard to breadth of grain, wherein " thinness " was dominant over " broadness ". Studies on endosperm inheritance showed that opaqueness was not a simple recessive character. Shedding of grain was mono-dominant over non-shedding.

The investigation to study the effects of soil and climatic conditions on the " quality " of rice was continued for the fourth year. Small plots of A28-6 were grown with seed produced at Hmawbi and locally at four centres in Lower Burma and at two centres in Upper Burma. A part of the produce from each place was dried in sheaves under sun for ten days, according to the local method, and another part under shed for the same period. The grains thus treated were examined at Hmawbi. In each case there were more sun-cracked kernels in sun-dried material than in that dried in shed. The percentage of whole rice was lower in sun-dried material in every case. Similarly, there was less moisture in sun-dried grain than in shed-dried grain. Sun-cracking appears to be influenced by the degree of ripeness of grain. There was again found a negative correlation between the outturn of whole rice in hulling and the amount of sun-cracked kernels. In another experiment, repeated second time with five varieties, the crop was cut at intervals of 20, 25, 30 and 35 days after flowering, and in each case part of the produce was dried in the sun for three days, but covered over at night, and another lot dried in shed for seven days.

The results show that: (1) the earlier the harvest, the lower the yield; (2) sun-dried material possessed more sun-cracked kernels than shed-dried grain and (3) in both the cases the amount of cracked kernels increased at the interval between flowering and harvesting increased, but in both the quantity of whole rice was more in earlier harvests. The crops harvested after twenty to twenty-five days after flowering possessed more green grain than those harvested after thirty to thirty-five days, the latter also giving kernels of better appearance.

MADRAS. During the year under report 9,890,000 acres were under rice in the province, representing 12 per cent of the total area under the crop. The estimated production during the year was 4,794,000 tons. In both acreage and yield, slight increases were registered over those of the preceding year.

At Coimbatore, nearly hundred varieties from Burma, Russia, Italy and Africa were added to the already large collection of rice varieties. A new strain Co 12, selected from the variety Sendhinayagam, is now ready for distribution. The three synthetic strains resistant to paddy blast and the two non-lodging strains continued to do well in the districts. At Pattambi, eleven varieties were investigated. Three strains, Mtu 9, Mtu 10 and Mtu 11, representing the varieties Garikasannavari, Sannakrishnakatukalu and Konamani respectively, were released during the year for general distribution from the Maruteru station. Promising strains from Akkulu and Atragada varieties are on hand. Selection work in the two popular varieties, Swarnalu and Kasipichodi, was also undertaken. At Aduturai, a strain from Vellaikar has given 14 per cent more yield than the standard and is to be released as Adt 14. A natural mutant from the strain Adt 4 (isolated from Basangi) has given nearly 24 per cent more yield than the standard variety and is also reported to have done well in the districts.

At Coimbatore, a variety Tellathokavadlu from Chittoor district was found to be highly resistant to alkalinity. Under Coimbatore conditions, transplanting has been found to give better results than dibbling, probably because the latter causes

premature lodging of the crop, due to shallow development of the root-system. At Pattambi, however, broadcasting in the first crop season in the double crop wet lands gave significantly higher yields than transplanting and late broadcasting. At Berhampore, broadcasting and transplanting are found to give equally good results, but the latter is safer to adopt as it gives a vigorous crop and is more likely to come off better in an adverse season. The " age of seedlings " experiment has confirmed again that thirty to forty days old seedlings at six inches showed best results in transplanting. Thin sowing has proved better than thick sowing.

Manurial trials at Berhampore indicated that application of superphosphate at 25 lbs. phosphoric acid with 4,000 lbs. leaf dressing fetches a profit of Rs. 2-14-0 per acre and the addition to this of three lbs. of nitrogen in the form of sulphate of ammonia increases the gain to Rs. 4-7-0. Similarly, twenty lbs. nitrogen applied as sulphate of ammonia with a basal dressing of 2,000 lbs. of leaf was more profitable than either forty lbs. nitrogen as sulphate of ammonia alone or the combinations of twenty and forty lbs. nitrogen with twenty-five lbs. of phosphoric acid. The addition of superphosphates, however, increased the yields progressively. The application of 100 lbs. Ammophos *plus* 4,000 lbs. of green leaf has given increased yields over leaf alone, but the fertilizer does not pay for its cost. The increased applications of green leaf from 2 to 10 thousands by increments of 2,000 lbs. in each application has a definite tendency to give progressively higher returns, the profits increasing with increased amounts.

The UNITED PROVINCES grew 6,080,000 acres of rice and produced 1,853,000 tons of paddy during the year. This represents about seven and $5\frac{1}{2}$ per cent of the total acreage and production respectively of rice in India. Both area and yield declined as compared to the last year.

At Nagina from among the imported varieties, a Chinese variety appears promising. The breeding part of the work consisted of minute study of characters of over 1,200 hybrid

cultures during the year. Many of the synthetic strains, involving the Sathi parent, possess better agronomic characters and are resistant to *Leptocorisa varicornis*. These are expected to be released to the cultivators shortly.

Vernalization of paddy in various ways showed no appreciable differences over normal seed. Germination studies with old and new seed showed that storage for seven to nine months after harvest decreases the viability at an average rate of six per cent per month. The age of seeds affects not only the capacity of germination, but also its rapidity, the older seeds requiring longer period to germinate.

Investigations on hulling indicated that greater moisture-content induces more breakage of grain, and longer exposure of grain to sun tends to improve the hulling quality.

In a manurial trial, phosphoric acid has had no effect on yield or maturity, but the nitrogen differences were significant. A mixture of sulphate of ammonia and sodium nitrate was not superior to either of the fertilizers alone. Application of sulphate of ammonia in two or three doses was more beneficial than in a single dose. Green manuring with sunn-hemp was found superior to Nicifos and nearly so to sulphate of ammonia. Manuring with whole plants of sunn-hemp was not better than the use of tops only as green manure. Sunn-hemp ploughed in when seven or nine weeks old gave higher returns than a five-week old crop. Application of molasses as manure " fired " the seedlings when applied just before transplanting.

CENTRAL PROVINCES AND BERAR. During the year under report, the estimated area was 5,624,000 acres giving an outturn of 1,765,000 tons. The area during the year shows slight increase over the last year's acreage, but the production shows an increase of 20 per cent. The rainfall was unusually high (90 inches) during the season as compared to the average of 49 inches. This seems to have contributed greatly in increasing the yield during the season.

Over 700 rices of different names have been classified under 385 different types. Agronomically desirable hybrids with

purple body have been obtained by crossing improved strains like Bhondu, Budhiabako, Gurmatia and Luchai with purple variety Nagkesar. In most of the crosses monogenic inheritance of 3 green leaved plants : 1 purple leaved plant was found. In one case, however, the ratio was 13 : 3.

Fifty-one varieties have finally been selected for large-scale trials for the Raipur tract and 59 and 53 for the Waraseoni and Jubbulpore tracts respectively. Selection in fine and scented varieties is also being made, and one of the selections, Kubrimohar-715, has proved superior to the local variety.

The extent of vicinism was also studied and it was found that it varies from 0·30 to 1·27 per cent and can take place up to a distance of ten feet.

Development of root-systems of the early strain E B 17, mid-late Parewa-22 and a late strain Gurmatia-17 was studied under transplanted, *biasi* (broadcasted and later cross-ploughed) and broadcasted conditions in *matasi* (25 per cent clay) and *dorsa* (48 per cent clay) soils. The transplanted plants showed in general the best development of roots, followed by *biasi;* the broadcasted plants showing the poorest development. Plants develop a heavier root-system in *dorsa* soil, but the yields in the other type of soil are generally better. Comparison of the above three varieties by the foregoing methods of planting in the two types of soils showed that transplanting and *biasi* methods were more or less equal and that both tended to be superior to broadcasting. Under irrigation experiments, standing water in the fields gave better yields in previous years than " water supplied as required " and " no irrigation ". During the season, however, there was no significant difference between the three treatments. These unusual results are attributed to the exceptionally heavy rainfall during the year.

A very large number of soil samples from various districts of the province were analysed. Heavier soils were found to contain more lime than lighter soils and most of the calcium present is in an exchangeable form. The amount and

availability of phosphoric acid follow no definite trend at different layers of the soil and in different places.

Among manurial trials with various combinations of sulphate of ammonia and superphosphate to give amounts of 0, 20, 30 and 40 lbs. nitrogen and phosphoric acid, the effect of each fertilizer separately was significant, the interaction between them being insignificant. Twenty pounds of phosphoric acid alone or in combination with 20 lbs. of nitrogen is equal economically, both the treatments giving a net profit of Rs. 4 per acre. Application in *matasi* soil of compost made of paddy-husks (at 40 lbs. nitrogen per acre) was better than the compost from *karanj* (*Pongamia glabra*) leaves, both, however, giving much higher yields than the unmanured plots. The farmyard manure, however, showed considerably better results than these two composts. In pot experiments with *matasi* soil, treated bone-meal was more or less as good as superphosphate.

The Agricultural Chemist to Government, Central Provinces, continued the investigations on the influence of phosphatic manures on yield and phosphoric acid content of paddy. Application of sunn gave better yields than the control. A combination of green material and phosphates proved significantly better than sunn-hemp. Application of nitrogen alone reduced the phosphoric acid content of the rice grain, whereas phosphatic fertilizers increased the amount of phosphoric acid.

In ASSAM, the rice area during the year under review was 5,440,000 acres, showing an increase of 148,000 acres over the previous year. The production of 1,793,000 tons also shows an increase of 183,000 tons over the last season, and represents nearly 5·5 per cent of the total produce in India.

At the Karimganj Farm nearly 1,000 types were under observation during the season and out of this number 263 were of agronomic importance. Preliminary and field-scale trials with broadcast and transplanted *aus* (autumn rice), *sail* (transplanted winter rice) and *arsa* (shallow water winter rice) groups of paddies were continued. In the final trial of broadcast *aus*, two strains, M. 175-2 and M. 175-1, have given significantly

higher yields than the standard strain, M. 36-30. Two better yielding synthetic strains—As C 536-48 and As C 536-143—are to be multiplied to replace the transplanted *aus* strain, Basmati As 3. In *sail* also two new strains are found which are intended to replace the standard Latisail.

Of the manurial trials with three doses of cow-dung of 100, 200 and 300 lbs. per acre, only the last one showed residual effect. A complex experiment consisting of three varieties (Latisail, Nagrasail and Kerrsail), four times of planting (15th June, 5th and 25th July and 15th August) and three spacings (6″, 9″ and 12″) was repeated for the second time with 2, 4 and 6 seedlings per hole. The analysis showed that all the primary effects were significant. Among the first order interactions, only that of spacing and time of planting was significant. Among the second and third order interactions none was significant.

The two main groups of paddy, *ahu* (autumn rice) and *sail*, are being mainly investigated at Titabar. During the year, over 900 types of the two main groups were under observation.

Under agronomic experiments, broadcast sowing at intervals of a fortnight in June to August showed regular deterioration in yield with delayed sowing. A factorial experiment with *sail* involving three ages of seedlings (4, 6 and 8 weeks), four periods of planting (5th and 25th July, 15th August and 5th September), three spacings (6″, 12″ and 18″) and three numbers of seedlings per hole (1, 2 and 4) showed that all primary effects, except the age of seedlings, were significant. Among the first order interactions those between ages and number of seedlings and age and spacing were insignificant. Similar was the case with the second order interaction between age, spacing and number of seedlings. In the third order interaction, time of transplanting, age of seedlings, spacing and number of seedlings were significant. An experiment involving four water-levels, *viz.*, 3″, 6″, 9″ and 12″, showed more or less the same yield under first three conditions, while there was a distinct fall in yield under the fourth treatment.

At Habiganj, a further collection of 370 samples of *aman* and 161 samples of *boro* (spring paddy) was added during the year. One of the *aman* selections has given over 4,000 lbs. of yield per acre. Some promising selections from *boro* paddies are also on hand.

Flood resistance of various varieties is being studied artificially. There are indications that high yield and resistance to flood are not necessarily correlated. Drought resistance is being studied by subjecting germinating seedlings to different periods of sunning and noting their ability to recover.

Broadcasting of dry seed at 60, 75, 90, 105 and 120 lbs. of seed-rate showed significant yield differences, the higher seed-rates tending to give higher returns. Trials of wet seeds at the same seed-rates, however, showed no appreciable differences. Among *boro*, transplanting did not give significantly higher yield than broadcasting. Comparison of an *aus* and a *boro* variety at 6″ and 9″ spacing showed no varietal as well as spacing differences. In a complex experiment involving four ages (4, 5, 6 and 7 weeks) and four numbers of seedlings (1, 2, 3 and 4), the primary effects showed highly significant differences, younger and more seedlings giving progressively higher yields.

BOMBAY. This province contributed roughly 2 per cent of the total area or 1,705,000 acres, and produced 657,000 tons of paddy or about 2 per cent of the total production.

At Karjat two improved strains, Z-149 and Z242, from the Zinya variety have been obtained. These strains are equal in yield to Kolamba-226 and are likely to replace it in the Thana district. An important coarse variety, Bhadas, is also being improved for south Kolaba and a promising strain from this variety is in the final stage of trial. Selections in the early variety, Kada of Surat and Thana districts, are also in progress. Similarly, the mid-late variety, Jirbuti, is also being improved. An improved strain from the coarse and red-grained Mahadi, largely used by poor classes of people, is on hand.

An early synthetic strain of Kolamba, K-501, has been obtained and is being compared with other early Kolamba

strains. Improved strains of Kolamba have been crossed with various other strains to obtain finer and pigmented types to distinguish them from the local green variety.

Improvement of fine rices of the Malenad tract is also in progress.

The early Masketi strain 1315, mid-late Jeddu-1061 and the late Halga-244 were all found to be again higher yielding than respective local varieties and sister strains at the Kumta Farm. It is of interest to note that Halga-244 appears to be resistant to *kane* (*Pachydiplosis oryzæ*) disease. Promising strains from Mugin-Bendu variety are also available. The Jeddu and Halga strains have been crossed with some Mugad strains and the crosses were in the F_2 generation during the year under report.

At the Rice Research Station, Karjat, manurial trials with castor and safflower cakes were conducted for the second time during the year under report. The two cakes were used singly on the basis of 40 and 60 lbs. of nitrogen per acre, and in combination with sulphate of ammonia, the latter supplying 10 lbs. of nitrogen with 50 lbs. of nitrogen from cakes. All the fertilizers were significantly superior to no-manure treatment. Among the manures, castor cake alone was better than safflower or combination. The higher doses of nitrogen showed significant increases in yield over the lower doses.

The estimated area in SIND during the year was 1,182,000 acres, showing an increase of 57,000 acres as compared to the area of the previous year. The production of paddy shows an increase of about 18 per cent over that of the previous year, the actual estimate being 455,000 tons.

As noted in the last year's review, the three improved strains, Kangni-27, Jajai-77 and Prong-36, continued to spread in North Sind. In addition to these, the new synthetic variety, Silver-Jubilee (Kangni-27 × Kolamba-184), continued to give satisfactory yields and was multiplied extensively on Government farms. Selections from hybridized material are also under preliminary tests.

Experiments on earlier transplanting—mid-May to mid-June—of the rice crop proved far better in yield than the local practice of late transplanting in July. In a badly infested *kalar* field (soil heavily infested with salts, mainly consisting of sodium chloride, sulphates and carbonates), a non-randomized trial of a synthetic strain, 16-1-28 (Kangni-27 × Torch), with crushed straw manure showed 45 per cent increase of manured plot over the no-manure plot.

PUNJAB. From eleven groups of rices, seventy strains were under trial at the Kala Shah Kaku Rice Farm. Two more prolific strains than 349-Jhona have been obtained. Similarly, a new strain has considerably out-yielded the old 370-Basmati A new strain from Palman rices is also on hand.

For the Kangra valley, a new rice station at Saloh was opened during the year under report.

Improved paddy strains were compared at the Karnal sub-station. A strain, T 164, has given much higher yields than the companion and control strains. Developmental studies of the rice crop are in progress at this station.

HYDERABAD. The area under rice in this State was estimated to be 1,135,000 acres during the year, showing an increase of about 6·5 per cent over that of the last year. The estimated production of paddy was 418,000 tons, which shows an increase of 82,000 tons over the previous year's yield.

Selection work and simple manurial trials on rice are being done.

The area under rice in the Mysore State was 724,000 acres and production 229,000 tons. The acreage during the year declined by 17,000, but the yield increased by a little more than 5 per cent over that of the preceding year.

The work on improvement of rice at the Nagenahalli Farm was continued. Selection 661 from G E B-24 of Madras gave good yields as in the previous year. A number of selections from the Maharajbhogam variety appear promising.

TRAVANCORE. The improvement of the rice crop chiefly consists in introducing better methods of cultivation and use of

organic manures available locally. Of the exotic varieties introduced, the famous Madras strain, G E B-24, is proving popular.

In COCHIN, extensive work on manuring with indigenous manures is being done. A number of varieties are under observation. The new selection, Cochin-I, from Chitteni, continued to do well in several taluks of the State.

In the DACCA UNIVERSITY scheme studies on assimilation and translocation of nutrients in the rice plant indicate that during the first five to seven weeks after transplanting, it assimilates nutrients at a faster rate than carbon, indicating that normally the intake of nutrients increases progressively. After the seventh week, however, carbon is begun to be assimilated at a faster rate until two weeks before harvest. If the growth of the rice plant is not vigorous in the early period, the plant may absorb 25 to 50 per cent of its total intake of nutrients after flowering. If, however, the development of the plant has been vigorous from the beginning, it may absorb as little as 5 to 10 per cent of its total intake of nutrients after flowering. These findings explain the apparent divergence between results of previous workers, some of whom found that the rice plant goes on assimilating most of its nutrients up to the flowering time, while others contend that it continues to do so even after flowering. Translocation of nutrients from straw to grain continued up to two weeks before harvest in plants from unmanured plots; whereas in plants manured with Nicifos, the activity continued up to the harvest period, indicating that the movement of nutrients is slowed up due to the application of manure. During the ripening period, considerable amount of nutrients is lost through the downward translocation from straw to roots.

Investigation on the Quality in Rice. This scheme is carried on at the INDIAN INSTITUTE OF SCIENCE, BANGALORE. Complementary work on the histological side, which was being done at Coimbatore, Madras, was completed during the year under report. In the last year's review, the changes brought

about in the rice grain due to parboiling were enumerated. In addition to these studies, a number of other investigations are in progress at Bangalore. Studies on digestibility of rice *in vitro* show that the rate of starch hydrolysis increases with increased polishing. Coarse polished rice shows greater digestibility than the coarse unpolished rice; the difference between polished and unpolished fine rice, however, is not much. Similarly, the difference between the milled and unmilled red rice is generally greater than that between polished and unpolished white rice. Rice bran inhibits the activity of the digestive ferments. Due to partial dextrinisation, unpolished parboiled rice is more quickly digested by the enzymes than raw rice. Consignments of rice are often subjected to sulphur fumigation. It has been found that such fumigated rice cooks to a pasty condition and has a distinct acidic flavour. The Bangalore work has shown that rice is inherently much more nutritious than is commonly supposed. Indeed it has been found that rice protein is even more nutritious than that of wheat. But the various practices of utilizing rice such as polishing, washing rice before cooking and draining off of *kanji* (liquid drained off after cooking rice) result in losses of valuable nutrients.

The main findings of the Coimbatore work are briefly summarized below :—

1. *Cooking tests.* The results of analysis of 174 samples indicate that: (*a*) parboiled rices require longer time to cook than raw rices, (*b*) the more the age of paddy after harvest, the more the expansion in volume of cooked rice, (*c*) parboiled rices absorb less water and consequently expand less than raw rices, (*d*) *kanji* is thinner in parboiled rice, indicating that less solids are removed from such a rice than from raw rice, and (*e*) finer rices generally possess higher expanding capacity than the coarser ones.

2. *Effect of storage on cooking quality.* Newly harvested and well dried paddy of an improved strain (G E B-24 of Madras) was stored in bins with and without ventilators at the

bottom and on the sides. Cooking tests of rice made at intervals of one month showed that as the age of the sample advanced, the cooked rice showed more expansion. Rice from the bottom-ventilated bins showed more expansion in volume than that from the side-ventilated bins which in turn showed more expansion over non-ventilated material.

3. *Starch formation in rice.* Studies on two starchy and two glutinous pure strains and a wild rice (*Oryza latifolia*) indicated that in starchy rices starch formation is confined to the pericarp layers for about ten days after fertilization and that it could be detected in endosperm cavity after four days. Until seven days after fertilization no starch appears in the embryo, but after this period it begins to increase up to twenty days, when it again largely disappears, the mature embryo showing only traces. In the wild rice, starch appears in the endosperm six days after fertilization and disappears completely from the embryo a fortnight after fertilization. In the glutinous rices starch is first deposited in an insoluble form in the ovary wall and appears in the endosperm cavity on the fifth day after fertilization where it is converted into soluble form.

4. *Protein formation in rice.* Formation of protein was studied from the third day after fertilization up to the maturity of the grain. Fresh specimens were found to be more suitable for study and the two reagents, Millon's and Adamkiewicz's, were the most satisfactory to detect the presence of proteins out of a large number tried. The deep red staining of the first two or three peripheral layers of the endosperm up to the seventh day indicated the presence of amino-acid, tyrosine; while the light-red reaction in the aleurone layers after this period showed the presence of the amino-acid, tryptophane. The deeper staining of parboiled rices indicated that in such rices proteins get diffused into deeper layers of the endosperm than in raw rices.

5. *Histology of the rice grain.* Spermoderm or the innermost cells of the inner integument is the seat of colouring

matter in rice. The coloured layers develop in different ways in different rices. In the case of white rices, this layer is completely disorganised by the time the grain reaches maturity. In red and light-red rices, the colouring matter fills up the cells completely, whereas in gray-brown and " gold ", it appears in globules. In a dark-purple rice, the colour spreads to the whole of the pericarp.

As regards the development of aleurone layers, it was observed that on the ventral side of the embryo the aleurone grains are generally single layered, while those on the dorsal side are two to three celled and the individual cells on this side are thicker than those on the other side. The thickness of the aleurone layer varies in different varieties and manuring, especially green manuring tends to increase the thickness considerably.

2. Wheat

General. There was a remarkable increase in the world price of wheat in 1936-37. The cause of this rise was a reduction in the carry-over of wheat, a succession of unfavourable crops in the larger producing countries and an increase in demand. As a result, India once again figured as a wheat-exporting country, her exports during 1936-37 amounting to 232,000 tons, as compared with the insignificant figure of 10,000 tons in 1935-36.

The area under wheat in India in 1936-37 was 33,237,000 acres and the total estimated yield 9,818,000 tons.

Breeding. Breeding for rust-resistance was continued at the research farm at SIMLA. The F_2 populations of eight crosses were tested and the results showed that the character of resistance was usually recessive. Plants were selected on the basis of rust-resistance and other desirable characters for production of the F_3 generation. The F_1 populations of a number of crosses, especially between Khapli and *vulgare* varieties, were also studied. The seeds from such crosses often did not germinate; and where germination took place, the plants almost invariably

died in the seedling stage. In the very few cases where the plants survived, the ears produced on them were very small and completely sterile. On the other hand, the crosses between *T. Timopheevi* and *T. vulgare* did not germinate. Crosses between *T. Vavilovianum* and *T. vulgare*, *T. dicoccum* and *T. durum* and *T. dicoccum* and *T. persicum* produced vigorous hybrids.

Forty varieties were collected from the hills and studied at Simla. It is intended to cross the best of them with other resistant wheats for the purpose of producing rust-resistant strains suitable for cultivation in the hills. Exotic varieties were also under investigation to discover strains suitable for breeding work.

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, New Delhi, work was in progress of eliminating the defect of grain-shattering in otherwise valuable varieties of Pusa 114 and Pusa 120.

In the BOMBAY PRESIDENCY, progress was made with the testing of selections and crosses obtained from previous research work, notably in Bansipalli and Khapli varieties. Promising segregates have been obtained from crosses Baxi × Bansipalli 808, Bansipalli 809 × Pusa 4, Bansipalli 808 × Polish, etc. Ninety-seven selections made from Khapli wheat were studied and were found to be slightly affected by rust in the later stages of their life. Fresh selections were also made. The F_1 plants from crosses between immune Russian and improved wheats were completely sterile, and although 1,000 back-cross pollinations were done, no seed was obtained. However, some seeds were obtained from out-crosses of the F_1 plants and these will be grown later.

In the PUNJAB, many new crosses were made at Lyallpur and at Lahaul. A large number of cross-bred wheats was under trial on a field scale for the first time. From the results obtained, there is reason to believe that a better wheat for *barani* (rain-fed) conditions than has been available hitherto

may be found. The opening of two new wheat-breeding sub-stations at Rawalpindi and Gurgaon has been approved.

In the CENTRAL PROVINCES AND BERAR, work was in progress in obtaining early, awned and rust-resistant strains. The F_4 generation of crosses, made with a view to improve the qualities of Haura wheat, were studied. The crosses between A 115 × P 4, A 115 × P 52, AO 68 × P 4, and between AO 68 × P 52 reached the F_4 generation. Crosses were made between AO 13 and A 115 into Kenya No. C 4062, in order to breed rust-resistant strains. As attempts made in the past to cross the rust-resistant Khapli with *vulgare* wheats had not been successful, an effort was made during the year under review to accomplish this cross indirectly by first crossing a *vulgare* variety with *durum*, and *dicoccum* (Khapli) with *durum*. The F_1s from these crosses will be crossed later with a *dicoccum* (Khapli) and a *vulgare* variety, respectively.

Wheats of known rust-resistant quality obtained from Australia and Russia were also kept under observation at Nagpur, but with the exception of four strains, all were severely attacked by rust.

In SIND, considerable work has been in progress with a view to evolve high-yielding, early-maturing varieties with a high degree of rust-resistance. A large number of selections and hybrids of different crosses was studied during the year.

Varietal and other trials. Trials of wheat varieties continued to be an important item of the work on this crop. In a series of trials conducted by the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE at Karnal and Pusa, Pusa 125 was the most successful among the Pusa wheats grown. This new wheat has been bred from a cross between Pusa 52 and Federation and is likely to prove promising. In the PUNJAB, the two new varieties, C 518 and C 591, are becoming rapidly popular, especially the latter which is prized for the excellent quality of its grain. Another new variety, C 409, was found to be particularly suited for conditions in the North Punjab. The department distributed 846,000 maunds of pure seed of C 591 to the cultivators

during the year. This quantity is sufficient to sow 140,000 acres. Judging by the enormous demand for its seed, it seems that in a very short time the previous popular variety 8A will no longer be the premier wheat of the province. About 3,200 maunds of smut-free pure seed of various important varieties were supplied to Deputy Directors of Agriculture and large grantee estates for further multiplication prior to distribution as seed. In the CENTRAL PROVINCES, six strains obtained from crosses between A 115 and Australian and Palestine wheats were under field-scale trial at Jubbulpore, Hoshangabad and Chhindwara. Of these, Nos. 76, 148 and 267 gave the most satisfactory results as regards yield and rust-resistance. At Adhartal Farm, two new strains, No. 346 (AO 13 × Florence) and No. 3463 (Red Pissi × P 4), showed high rust-resistance and good yield. Twelve fixed strains from crosses AO 13 × P 4 and AO 90 × P 4, produced to meet the requirement of the plateau districts, were grown in randomised blocks on various farms. Nos. 3439 and 3463 showed the best results. In BIHAR, a large number of varietal trials was carried out. Pusa 52 continued to be the most successful wheat. This variety is reported to be very popular with the cultivators and in South Bihar it is well known as ' Collegia ' wheat. Under certain conditions, Pusa 165 also gave a heavy crop but, being awnless, it is not so popular with the ryots. In SIND, nine Pusa wheats were tested in row-tests with the standard local improved variety, CPh 47, which proved the best as regards yield. Among the Pusa wheats tried so far, Pusa 114 on account of its high rust-resistant quality has suited the Sind conditions best. Of the varieties newly imported from the Punjab, Punjab 8A and C 591 gave very good yields. A number of promising hybrid strains were subjected to field tests. Strain Nos. 21 and 37 from the cross between CPh 47 × Pusa 12 and Strain No. 139 from the cross between AT 38 and Pusa 12 were found promising both as regards yield and quality. A large number of other trials was also conducted both under irrigated and *bosi* (without cold season irrigation) conditions and the

Agricultural Department is now in possession of reliable information regarding the yielding capacity of improved wheat varieties for different wheat-growing tracts. In the BOMBAY PRESIDENCY, varietal trials included the district trials of the two Bansipalli strains 808 and 809. The former, as usual, was decidedly superior to the local varieties against which it was tested. In BENGAL, the Pusa wheats under trial again outyielded the local varieties. At the INSTITUTE OF PLANT INDUSTRY, INDORE, six selections of *durum* wheat were compared against the local variety of the farm; out of these R 14, a red-grained wheat, showed the best results. Owing, however, to the red colour of its grain, it was valued at 15 to 25 per cent lower than the local wheat. In the south of the NORTH-WEST FRONTIER PROVINCE, in the Dera Ismail Khan district, Punjab 8A is the most popular. In Bannu, Bena holds the field and has stood first by a comfortable lead in practically every trial. In Peshawar, although the Punjab wheat C 518 has proved the heaviest yielder and is a high class hard wheat, zamindars even in nearby villages prefer Pusa 4, the beardless variety, which they find easy to harvest as compared to the bearded C 518. In Haripur, Pusa 165 is popular. C 591, introduced during the year under report, is much appreciated by the more enlightened zamindars owing to its high quality. In the Southern Circle, 8A and C 518 have shown themselves to be the best for *barani* conditions. Sowing in lines 12″ apart has given a bigger return than 9″ and 15″—the distances found optimum in the Punjab and Sind respectively. Repeated experiments have shown that 10 per cent higher yield is obtained by sowing in lines than by broadcasting. In manurial trials, C 518 gave the maximum yield of 45 maunds per acre and sixteen maunds more than the control, with an application of three cwt. of *shora* bone-meal per acre. *Guara* (*Cyamopsis psoraloides*) as a green manure was found better than sunn-hemp. In an experiment to determine the best time for sowing wheat, October 20th to November 10th has been found to be the best period for sowing. In tillage experiments,

the soil-inversion plough gave better results than the *desi* (indigenous) hoe. This is contrary to what has been experienced at Lyallpur.

Quick-maturing wheats were obtained from Norway and Finland and sent to Chitral for sowing at elevations of 12,000 feet and over. The crop matured, but the yield was not economic.

KASHMIR. Punjab wheats do not fare well in Kashmir because of climatic conditions. The principal defect lies in threshing, particularly wheat No. 8A, in which grains separate with great difficulty. In a varietal trial of eight awned varieties—four foreign and four local selections—the highest yield of twenty maunds grain per acre was obtained from a local red wheat. In another trial of eleven awnless foreign varieties, the highest yield of twenty-four maunds was obtained from Ford—an Australian variety. The seed of this variety of wheat is in great demand. Its grain is plump and white. C 591 is doing better than 8A since last year under both irrigated and unirrigated conditions.

Miscellaneous. *Registration of Wheat Varieties.* At the instance of the Standing Wheat Committee of the Imperial Council of Agricultural Research, the Imperial Agricultural Research Institute undertook to maintain a register of (*a*) wheat varieties of commercial importance in India, and (*b*) wheat varieties likely to be of value for breeding work in India. In this connection about one hundred samples of wheats received from various provinces and States were under study.

Genetical Studies. An investigation was carried out at Pusa on the influence of certain external factors upon the manifestation of hybrid vigour in a cross between Pusa 52 and Pusa 165.

Other work on wheat included manurial experiments, vernalisation studies, etc.

3. Cotton

DURING the year under review, the area under cotton in India (including Burma) decreased to 25,148,000 acres from 25,962,000 acres in the preceding year. The reduction, however, was confined mainly to the Hyderabad State and parts of Bombay Presidency, where sowing conditions were unfavourable. The total estimated outturn (including Burma) for 1936-37 was 6,261,000 bales of 400 lbs. each, as against 5,918,000 bales for 1935-36, the yield establishing an all-time record and breaking the 1925-26 record of 6,215,000 bales from an area of 28,403,000 acres. The average yield amounted to 100 lbs. per acre and was the highest ever recorded. In the preceding year, the average yield was 91 lbs. per acre. The total crop accounted for by press returns and loose cotton consumed in mills was 6,845,686 bales during the year against 6,417,273 bales in 1935-36.

The parity of Indian cotton was very favourable during the greater part of the year and for a time the price of Indian cotton was the lowest compared with other cottons. As a result, exports of Indian cotton reached the record figure of 4,354,000 bales against 3,826,000 bales in 1935-36.

According to the statistics compiled by the International Federation of Master Cotton Spinners' and Manufacturers' Associations, the world's total mill consumption of Indian cotton, exclusive of Italy (for which figures are not available), showed an increase from 5,445,000 bales during the year ending 31st July 1936 to 5,948,000 bales during the corresponding period of 1936-37. Indian cotton consumed in mills in India amounted to 2,631,296 bales of 400 lbs. in 1936-37 against 2,677,688 bales in 1935-36.

The work of cotton improvement in India continued to be largely financed by the INDIAN CENTRAL COTTON COMMITTEE. The Committee aims at supplementing, and not supplanting, the work of the Agricultural Departments in the cotton-growing provinces and Indian States, its general policy being to give

assistance in the directions where it is most needed in the carrying out of schemes for cotton improvement. A brief account of the work done during the past year, by the combined efforts of the various Agricultural Departments and the Indian Central Cotton Committee, is outlined in the following paragraphs :—

The ascertained area under improved cottons during the year was 21 per cent. of the total in 1935-36, and the gain to the cultivator in many tracts was clearly much greater. Good progress was maintained in the development of the Indian textile industry, resulting in increased takings of Indian cotton and a greater demand for cotton of medium and long staple. A big increase was recorded in the taking of Indian cottons by mills in the United Kingdom, largely due to the efforts of the Lancashire Indian Cotton Committee. The total imports of Indian cotton into the United Kingdom amounted to 658,000 bales against 547,000 bales in the previous year. While there has been a steady increase in the production of cottons of $\frac{7}{8}$ in. staple and over, India's cotton exports still consist mainly of short staple types for which Japan, so far, has been the most important market. During the past two years, however, there has been a steady rise in the imports and utilisation of these short staple cottons in the United Kingdom, due to the improvements in technique resulting from the work of the Shirley Institute and the Lancashire Indian Cotton Committee. Indian cotton has thus found definite new outlets in the United Kingdom which, it is hoped, will be permanent. In addition to aiming at the production of better cotton, special attention continued to be devoted to better marketing, to the prevention of adulteration and to many other problems connected with the cotton trade of the country.

Cotton Transport Act. The Cotton Transport Act, passed by the Government of India in 1923 at the instance of the Indian Central Cotton Committee, empowers Provincial Governments to exclude from any specified area cotton, *kapas* (raw cotton before extracting the seed) or seed, from

outside, unless required for a special purpose and covered by a licence. Under this Act protected areas have been established with a view to maintain the reputation of the superior cottons grown therein. During the period under review, the Northerns and Westerns area of the MADRAS Presidency was shifted from Settigunta to Razampetta Railway Station—a distance of thirty-seven miles in the interior—with a view to stopping illicit movement of cotton into the Southerns tract. There was no change in the protected areas notified in the BOMBAY Presidency. In the CENTRAL PROVINCES, the old district of Seoni was deleted from the protected area, and the Narsinghpur sub-division of the Hoshangabad district was included in it. The railway route along which cotton transportation is prohibited, except under licence, was extended from Piparia to Bankheri. The stations of Kaher, Vyara, Doswada and Fort Songhad on the Tapti Valley Railway were included in the schedule of railway stations under the Baroda Cotton Transport Act. There was no change in the protected areas in Hyderabad, Indore, Sangli, Rajpipla, Chhota Udepur, Baria and Lunawada States. A few minor Indian States, *viz.*, Bhaderwa, Kadana, Sant, Sanjeli and Jambughoda, which grow superior cottons have also issued notifications declaring the portion of the Narbada-Mahi protected zone, lying within their respective territories, to be a protected area.

A noteworthy feature of the year was the promulgation of the Central Provinces *Cotton Control Act*, which prohibits the cultivation or mixing of Garrow Hill cotton, a very inferior short staple, prolific variety, which was threatening to mar the reputation of the superior Central Provinces cottons.

Improvement of Cotton Marketing. Side by side with the measures for the improvement of the quality of cotton in India, considerable advance has also been made in the sphere of cotton marketing. *The Cotton Ginning and Pressing Factories Act, 1925*, applies to the whole of British India, and practically all cotton-growing Indian States have passed parallel legislations. This Act requires every bale of cotton to be stamped with a

mark showing where it was pressed. Certain other matters dealing with the management of ginning and pressing factories were dealt with, and regular returns of cotton pressed each week were made compulsory. Experience has shown, however, that the mere tracing of malpractices to their source is not effective in suppressing the evils of watering, fraudulent packing, adulteration of cotton, etc. Accordingly, the year under review witnessed the enactment of legislation by the BOMBAY and the CENTRAL PROVINCES Governments making it obligatory on all cotton-ginning factories, situated in areas to which the Act is applied, to take out licences and prohibiting watering, mixing or admixture of cotton. The amended Act was put into force in the Central Provinces from the beginning of the current season, and beneficial effects have already been reported by the trade, and there has been a widening of the demand for the Central Provinces cottons. Among Indian States, legislation for the licensing of ginning and pressing factories is in force in HYDERABAD and HOLKAR STATES.

Cotton Statistics. The Cotton Forecast Improvement Sub-committee of the Indian Central Cotton Committee continued to devote its attention to the examination of the all-India cotton forecasts, in the light of information available at the close of the season, with a view to discovering sources of errors and devising remedial measures. During the year, the Committee decided to publish annually a report on the accuracy of the all-India cotton forecasts of each season for general information and, accordingly, Statistical Leaflet No. 5 entitled " Report on the accuracy of the all-India cotton forecasts of 1934-35 and 1935-36 seasons " was issued. As a result of the work done under the Bombay Cotton Forecast Improvement Scheme, financed by the Committee for tackling the cotton forecast problems of the Bombay Presidency (including Indian States) and Sind, the standard yield figures for cotton for the Presidency and Bombay States were revised during the year; the adoption of the new figures with effect

from the forecast of 1937-38 is expected to lead to an improvement in these statistics.

It is hoped to publish shortly the results of the enquiries into the village or extra-factory consumption of cotton in India, referred to in the last review.

Statistics were compiled and published as usual dealing with the consumption of Indian cotton by Indian mills, the distribution of the crop by staple length and receipts of cotton at mills, exports by sea and stocks held in India classified according to varieties. Besides the Statistical Leaflet No. 5 referred to above, another publication entitled " A Guide to Indian Cottons ", jointly produced by the East India Cotton Association and the Indian Central Cotton Committee, was issued by the Committee during the year and has proved to be very popular.

Malpractices. Seven cases of mixing seed with lint, false packing and watering were reported to the Indian Central Cotton Committee during the year, and the malpractices were brought to the notice of the authorities concerned.

Cotton markets. The Committee has devoted much attention to the improvement of primary cotton marketing and with considerable success. Investigations conducted in the provinces and States in connection with the financing and marketing of the cotton crop in the up-country areas have, amongst other things, brought to light the evils of the existing primary marketing system which deprives the grower of a fair share of the value of his produce, and the attention of the provinces and States has been drawn to the desirability of establishing regulated cotton markets in their respective areas. There are now five such regulated cotton markets in the Bombay Presidency, seven in the Central Provinces and Berar, one in the Madras Presidency and several in the Hyderabad State. The latest development is the provision, by the Indian Central Cotton Committee, in co-operation with All-India Radio, of a limited number of rural broadcast receivers in suitable markets for the broadcasting of cotton prices.

As a preliminary to the introduction of Universal Standards for Indian cottons in the country, efforts are being made by the Committee for the adoption of common standards by the East India Cotton Association and the Karachi Cotton Association —the two established Exchanges controlling cotton trading in India at Bombay and Karachi respectively. During the year, standards for different varieties of cotton were passed by the Standards Sub-committee of the Indian Central Cotton Committee. The Karachi Cotton Association have accepted the Universal Standards of the Committee as the basis for their own standards, and trading during the year was done on that basis. The Standards Committee of the East India Cotton Association have recommended to the Board of Directors of the Association that the Universal Standards should be adopted as the basis for the preparation of the official standards of the Association subject to the reservation that the remaining standards should be prepared by the Standards Committee of the Association as heretofore.

Seed Distribution. In order to translate the results of botanical and other research into practice, a system of pure seed-supply of improved varieties of cotton has been organised with the aid of funds provided by the Indian Central Cotton Committee.

Seed Schemes. There were several seed-schemes in operation during the year in different provinces and States. In the BOMBAY Presidency, schemes were in operation for the extension of Jayawant and Gadag No. 1 around Hubli, Gadag and Athani; Banilla in Khandesh and Deccan Canals; 1027 A L F in Surat tract; B D 8 in Broach tract and (Jarila) N V 563—a Verum selection—in Khandesh tract. In SIND, seed of 4F-98, Sind Sudhar (289F-1) and Sind N R is being extended as rapidly as possible. A combined scheme, financed by the Indian Central Cotton Committee, for the extension and marketing of Verum cotton was in operation in the CENTRAL PROVINCES and BERAR. In the MADRAS Presidency, the multiplication and distribution of pure Co 2 seed is being carried

out, while in the UNITED PROVINCES C 520 and C 402 are being extended. Two schemes were working in the HYDERABAD and BARODA States for the extension of Jayawant and 1027 A L F cotton respectively.

Technological Laboratory. The resources of the Laboratory continued to be availed of, as in the past, by agricultural officers for assessing the spinning value of their new strains. Spinning mills utilised to a much greater extent than in the past the facilities afforded by the Laboratory for the testing of their samples or the solution of their problems. The results of tests on trade varieties of Indian cotton supplied by the East India Cotton Association, the Ahmedabad and the Bombay Millowners' Associations and those on standard cottons supplied by the Agricultural Departments were published as usual in the form of Technological Circulars which were subsequently compiled in the form of bulletins under the title of Technological Reports on Trade Varieties and Technological Reports on Standard Indian Cottons. Other investigations of interest during the year were :—(1) spinning tests on mixtures of staple fibres and Indian cottons, (2) tests on Indian cottons with different systems of high draft spinning, (3) effect of storage on seed cotton prior to ginning, (4) limit spinning tests, (5) combing of Indian cottons, (6) effect of storage of lint on its quality, (7) quality of lint in relation to ginning factors, (8) deterioration of Broach (Palej) cotton with lapse of time and (9) effect of pre-humidification on the spinning performance of a cotton.

Research on the possibility of utilisation of short staple Indian cotton for the manufacture of artificial silk was continued in collaboration with the Industrial Research Bureau.

The Institute of Plant Industry, Indore. The Institute completed its thirteenth year of life during the year. The preliminary study of the indigenous and introduced cottons of Kathiawar, which was undertaken at the instance of the Indian Central Cotton Committee in 1935, has resulted in the selection of a large number of promising single plants in Wagad cottons.

Cotton samples belonging to the *arboreum* var. *neglectum* group received from Burma and Assam were grown in the Institute and selection made for quality combined with good ginning percentage. The pick of this material was used in hybridisation in connection with the Bengals Improvement Scheme in progress at Sriganganagar.

As regards selection and breeding, the principle of basing selection on variance as well as mean values has been exploited by the replicated progeny row technique that has been evolved at the Institute. During the year, two experiments, one on Malvi cotton and the other on *jowar* (*Andropogon Sorghum*), were carried out to test the efficacy of selection by the special technique. The previous trials having conclusively proved that Malvi 9 is a great advance in quality over the local Malvi crop, the only trial conducted during the year was that with the sub-strain of Malvi 9 at four centres. Out of the five sub-strains, No. 20 appears to be the more suitable to replace Malvi 9. While giving the same acre yield as Malvi 9, No. 20 is definitely superior to Malvi 9 in quality. Experiments on cotton physiology, pathology and agronomy were continued and progress recorded.

A brief account of the work done in the various provinces during the year under review is given below :—

BOMBAY. (*a*) *Gujarat*. The work of cotton improvement in the Gujarat Division is centred at Surat, Broach and Viramgaon, at all of which places, scientific botanical research work is in progress towards the production of improved strains of cotton which will give higher returns per acre to the cotton-growers.

Botanical work on cotton improvement at Surat. At Surat, work is being concentrated on the production of a strain of improved Surat cotton which will possess the high spinning qualities of the improved 1027 A L F variety, already introduced and extended by the Agricultural Department, and which, at the same time, will give a higher ginning percentage similar to other improved strains of Surat cottons. Selections

have been obtained which give a ginning percentage higher than 1027 A L F by 3·4 per cent. but which are somewhat shorter in staple-length than that variety. During the year under report, a number of fresh crosses have been made which aim at combining the desired characters and there are indications that the solution of this important problem is more likely to be obtained by such hybridisation work than by any further selection among the existing Surat cottons.

Broach Cotton-breeding Scheme. At Broach, the cotton-breeding work is being financed by the Indian Central Cotton Committee and the year under report was the fifth year of the scheme. The work has for its object the breeding of suitable types of cotton for the Nerbudda-Mahi zone which will be wilt-resistant, heavy-yielding, high-ginning and which may replace the inferior local mixture, consisting largely of Goghari. N S 12 was tested in replicated plots with B D 8, the improved variety now being distributed in Broach district by the Agricultural Department and it was found to give considerably higher outturns per acre. B D 8 appeared to be adversely affected by the unfavourable seasonal conditions which prevailed during the season. At this centre, hybridization work is also in progress and two crosses, *viz.*, B D 8 × G A 26 and B D 8 × (B D 8 × G A 26) were grown on a fairly large scale during the year under report. Segregates have been obtained from both these crosses which are more satisfactory than the original parent material and are being retained for further study. Segregate 6 has given a ginning percentage of 36·9 with a fibre length of 22·0 mm. and showed no signs of wilt in the field. The replacement of the local mixture by such a cotton in the Nerbudda-Mahi zone would add lakhs of rupees to the profits of the cultivators.

Botanical work on cotton improvement at Viramgaon. Two promising segregates from the cross Wagad 8 × 1027 A L F were tested in comparative yield trials but significant results were not obtained. Further trials are being continued. The Indian Central Cotton Committee has undertaken to finance a research

scheme for the improvement of Dholleras-Wagad cotton at Viramgaon and work will be started in the current year.

(b) *Khandesh.* Cotton improvement work in Khandesh is financed by the Indian Central Cotton Committee and is carried out at the Government Farm, Jalgaon. The main object is to obtain, by unit selection, or by hybridization, suitable wilt-resistant types of Khandesh cottons with high-yielding, high-ginning and good spinning qualities to replace the local Banilla or N R varieties.

Khandesh Cotton Breeding Scheme. The three promising strains of *neglectum* Verum, *viz.*, N V 57-7, N V 56-3 and N V 56-17, referred to in the last year's report, were compared for yield on replicated plots for the third year. These trials were also conducted on Bhadgaon and Dhulia Farms. N V 56-3 gave significantly higher yields than the other two strains and the local varieties, *e.g.*, N R 6 and Banilla. In district trials on cultivators' fields, the same strain, *i.e.*, N V 56-3, proved, in general, superior and has gained a good reputation among the cultivators. This strain, which has been named " Jarila ", was also satisfactory in spinning tests at the Technological Laboratory, Matunga and at local mills, and the seed is now being multiplied for distribution in the districts. In this work, financial assistance has been made available by the Indian Central Cotton Committee. Jarila cotton, grown at Jalgaon Farm, fetched a premium of Rs. 28 per *khandy* (two bales) over the local variety in local sales.

(c) *Southern Division.* The work of botanical research on the cotton crops of the Southern Maratha Country is centred on the Government Farm, Dharwar.

During the year under report, work on strains of Jayawant × 15 cross was continued. It is hoped to obtain from this cross a New Jayawant cotton, which will be as good as the present Jayawant variety in spinning qualities but with a higher ginning percentage. As a result of a series of replicated plot tests, one strain, *viz.*, Jayawant × 15 (11-014), proved

superior to Jayawant in yield and ginning percentage and equally good as regards staple.

Cotton Wilt-breeding Scheme. As a complement to the cotton-breeding schemes in Broach and Khandesh, scientific research work on the breeding of wilt-resistant strains of cotton suitable for these two tracts is being undertaken at Poona with the help of the Indian Central Cotton Committee.

(a) *Broach section.* During the year under report, the seed from fourteen healthy plants obtained from B D 8 cultures last year was tested separately and a fifty-day test under optimum conditions of infection, in which 12,338 individual plants were under observation, resulted in the retention of only seventeen plants which were free from wilt symptoms and which have been transplanted in an infected plot for further study.

(b) *Khandesh section.* Trials for wilt-resistance under optimum conditions of infection were continued with plants of the Million Dollar variety and with different strains of *Gossypium arboreum* var. *neglectum*, collected from different parts of India and Burma. 131 plants of Million Dollar were found free from leaf-mottle and have been retained for further investigation. All the *neglectum* strains, except Chinese R. I Spotless, succumbed to wilt disease. The important practical aspect of this work is the isolation of a highly wilt-resistant strain for hybridization with the best *Neglectum verum* strains obtained under the Khandesh Cotton-breeding Scheme at Jalgaon.

Seed supply. During the year under report, there were six organised seed-distribution schemes for improved varieties of cotton in force in the province. In all these schemes, financial assistance was given by the Indian Central Cotton Committee, Bombay.

(a) *Surat Seed Distribution and Extension Scheme.* This scheme deals with the distribution and extension of the improved cotton variety 1027 A L F in Surat district. During

the year, 2,643,064 lbs. of seed were handled by the Department, of which 1,556,409 lbs. were supplied to Rajpipla, Chota Udaipur and Idar States and 1,086,655 lbs. were distributed through twenty-four seed depots in the Surat district. In addition, approximately 293,046 lbs. of 1027 A L F seed were supplied directly by Co-operative Cotton Sale Societies, etc., to their members. The continued existence of a higher ginning, but inferior quality, cotton, *viz.*, Surat 1A, in this district, where it is preferred by many cultivators, is affecting the extension of the 1027 A L F variety and a revision of departmental cotton policy in Surat district is under consideration. The seed-production area under departmental control and grown with pure 1027 A L F was 25,582 acres.

(b) *B D 8 Seed Distribution and Extension Scheme, Broach.* This scheme is devoted to the distribution and extension of the high-yielding and wilt-resistant strain of improved cotton, *i.e.*, B D 8 in Broach district. From a controlled area of 1,000 acres, 456,600 lbs. of seed were obtained, together with 615 bales of B D 8 lint. The latter were sold at a premium varying from Rs. 37 to Rs. 53 per *khandy*. About 200,000 lbs. of seed have been distributed over an area of 20,000 acres. Owing to uncontrolled and indiscriminate mixing of B D 8 with inferior local cotton, this improved variety failed to obtain an adequate premium, especially towards the end of the season. Attempts are now being made to market B D 8 pure under a departmental mark and guarantee so as to fetch higher prices to its growers.

(c) *Revised Jayawant and Gadag No. 1 Seed Distribution and Extension Scheme, Southern Division.* Work in connection with the distribution of Jayawant cotton seed was undertaken from seven centres which were later reduced to six. The reserved area under pure Jayawant at six centres was 25,006 acres and 1,568,644 lbs. of seed were stocked, of which 862,643 lbs. were distributed by departmental agents. Gadag No. 1 seed was produced on 22,614 acres at two centres and 844,250 lbs. of pure seed were distributed. The total areas

grown with Jayawant and Gadag No. 1 cottons during the year under report were about three lakhs and one lakh acres respectively.

(d) *Banilla Seed Distribution and Extension Scheme, Deccan Canals.* This is a combined multiplication and distribution scheme which aims at the extension of Banilla cotton in the areas irrigated by the Deccan Canals. During the year under report, thirty-one acres of pure Banilla cotton were grown at the Kopergaon Farm and 8,875 lbs. of pure Banilla seed were distributed to departmental registered seed-growers. Owing to insufficient rains, yields were poor. The working of this scheme during the past three years shows a net profit of Rs. 570.

Plant-puller Propaganda Schemes, Broach and Surat. A notable instance of effective organization against a serious insect pest of crops is to be found in the above-noted schemes which aim at organizing the cotton-growers of Broach and Surat districts to remove the cotton stalks from their fields after harvest and so check the spread of boll-worm damage by preventing the carry-over of the pest from one season to another. This work is financed by the Indian Central Cotton Committee. Thousands of plant-pullers have been distributed in the districts. In Broach, Amod and Wagra taluks, about 95 per cent of the cotton area was uprooted and, in the areas south of the Nerbudda, about 46 per cent of the total cotton area has been cleaned after harvest. Work is now being concentrated in backward taluks with the ultimate object of 100 per cent clearance in the Gujarat cotton-growing tracts.

MADRAS. At Coimbatore, the season was not particularly propitious for research work on cotton. In order to hasten breeding work in Cambodia cotton, it was found desirable to produce two generations of cultures in a single year instead of one. To this end, a small area was leased at Srivilliputtur in Ramnad district where Cambodia strains were grown from March to September. The best among these were brought back again to Coimbatore for the September sowings.

Co 2, which is the most popular strain in Cambodia and which occupies more than two lakhs of acres in this presidency, has the disadvantage of being late in maturing and is therefore not quite suitable for rain-fed areas. With a view to evolve earlier types, a number of varieties were imported from other countries to isolate suitable types either by selection, hybridisation or acclimatisation.

At Koilpatti, Kpt 1 strain led other strains giving a yield of 366 lbs. per acre, as compared to A 10 and C7 which gave 324 lbs. and 320 lbs. per acre respectively.

At Hagari, it has been observed that H 1 deteriorates when grown under ryots' conditions for four or five years. It was also noticed that the yield and quality of lint obtained from non-fuzzy H 1 seed is inferior to the fuzzy. Therefore even a small mixture of the non-fuzzy type is bound to cause deterioration.

At Nandyal, cotton strain No. 1346 from *indicum* gave consistently higher yields than N 14 during the last three years. The difference this year in favour of the strain was as much as 44 per cent.

At Guntur, forty-four fresh selections were made during the year and six of the previous year were put to comparative trials.

Hybridisation. Out of 892 cultures, twenty-eight cultures gave higher yield than the standard and were earlier by about a month. Co 2 was hybridised with a drought-resistant wild cotton of Hawaii. Steps were also taken to evolve cottons of finer and longer fibres by crossing Co 2 with the famous Egyptian and Sea Island cotton varieties.

The mode of inheritance of plant height, lintlessness and colour of lint were under further study. The study of the distribution of the Jassid, an important insect pest on the American cotton, was pursued to a greater degree this year. It was observed that the relationship between leaf-hairiness and intensity of Jassid incidence was not as close as is generally supposed to be.

A number of Mungari strains in the Bellary district were compared in five centres.

Schemes financed by the Indian Central Cotton Committee.

(1) *Madras Herbaceum Scheme.* As a result of crossing with different varieties, a large amount of material, good in lint-length, ginning percentage and yield, was obtained. Strain 4714, evolved as a result of research work on this scheme, was put under field trials in the districts. It is observed that this strain is suited to seasonal conditions prevailing in tracts up to Virudunagar. Reference was made last year to the disadvantage of its having a narrow leaf which might be mistaken for short-stapled Roseum cotton. This has since been obviated by the isolation of a broad leaf mutant which gave as much yield as the strain itself.

(2) *Madras Pempheres and Physiological Scheme.* Last year an interesting connection between the extent of water-soluble polysaccharides in the stem and the readiness of the plant to produce gum to arrest the development of the insect was noticed. Further observations and analysis, however, during the year indicated that the amount of polysaccharides formed depended on the seasonal conditions. It has also been found that the composition of the polysaccharides of the leaves differed from that found in the wood, and therefore attempts at selection of resistant types cannot be made only from analysing easily removable parts like the leaf and petiole.

It was also observed that *Pempheres* had at least ten other hosts, mostly weeds, which indicated that it might be an indigenous insect which developed into a pest on the introduction of Cambodia which seems to be such a suitable host.

The introduction of parasites on the *Pempheres* has met with a limited success. Two more parasites were collected from weevil grubs developing in alternative food plants. Though sixteen different species of the borer parasite were imported from northern India, only two were able to parasitise on the *Pempheres* and that inefficiently. *Spathius*, the local parasite, continued to give encouraging results.

The isolation of strains in Karunganni, resistant to shedding, was continued at Koilpatti with promising results.

(3) *Madras Nadam Breeding Scheme.* Rainfall was deficient by ten inches which made the crop stunted and poor. Even the local Nadam variety, which ordinarily yields 60 lbs. in the first year and 200 lbs. in the second, produced this year hardly any crop in the first year and about 100 lbs. in the second year. Four of the exotic types were tried on the cultivators' field, two of which yielded more than 100 lbs. per acre. Nadam cotton remains in the field for a number of years, while the new types have to be sown afresh every year. In spite of this disadvantage it is found that the cultivation of these types still leaves a margin of profit. It is also observed that the time of sowing is more important than even manuring or ridging.

(4) *Madras Fodder Cholam* (Sorghum vulgare) *Scheme.* It was definitely established that the deleterious effect of sorghum was due to the rise of sodium salts from the lower layers. Growing of sorghum along with pulses did not improve the soil condition. Cotton sown thick was able to induce normal yields. Correctives like gypsum, sulphur and magnesium sulphate had no appreciable effect on sorghum. Application of molasses as a corrective to alkalinity showed better growth in the treated plot.

Seed Distribution. (*a*) *Cambodia cotton.* In view of its good staple-length and yield, this cotton is gaining popularity throughout the presidency wherever irrigational facilities are available. Strain Co 2 continues to be popular, although, as has been stated elsewhere in the report, steps are being taken to replace it by other better strains which would, however, take some time to displace it. In all, 249,355 lbs. of seed of this strain were distributed during the year for seed purposes of which the VIII circle alone was responsible for nearly 148,000 lbs. The Tiruppur Co-operative Trading Society also produced a large amount of seed of this strain and distributed in and outside Coimbatore district. In the VIII circle, it is estimated that 1½ lakhs of acres are now under this strain. In the VI

circle, there were 221 acres under seed-farms. A ryot in Manaparai in the V circle ginned at the instance of the department cotton *kapas* and reserved nearly 20,000 lbs. of Co 2 seed for distribution among ryots. In this presidency, 206,550 acres were under this strain as against 213,339 in the previous year.

(b) *Karunganni cotton.* This cotton is grown in the V, VI and VIII circles. There were 1,946 acres under seed-farms for production of good seed, and 60,624 lbs. of seed were distributed. The strains that are recommended are Kpt 1, C 7 and A 10. It is estimated that 165,440 acres were under this cotton as against 182,255 acres last year.

(c) " *Westerns* " *cotton.* This cotton is confined to the III circle, N 1 being the strain that is under distribution. There were 2,554 acres under seed-farms which were sufficient to meet the requirements of the circle. One hundred and forty-eight thousand and eighty-seven pounds of seed were distributed as against 69,520 lbs. in the previous year. The quantity distributed varies according to the previous season and market demands; it is reckoned that the increased return obtained by growing this strain is Rs. 2-8 per acre. There are about 239,500 acres under the strain.

(d) " *Northerns* " *cotton.* In view of the gradual improvement in price of " Northerns " during the last two years, the cultivation of strain No. 14 was pushed through in places where it was once popular. As has been stated before, this strain can be successfully cultivated only in certain localities and steps were therefore taken to encourage the sowing of this strain wherever it could be profitably grown. Efforts are being made, however, to find a more cosmopolitan strain suited to the local conditions of soil and rainfall. About 12,730 lbs. of seed were obtained from seventy-eight acres of seed-farm. The area under this cotton is 3,925 acres.

The total area under cotton in the British districts of the PUNJAB during 1936-37 was 2,910,000 acres against 2,803,000 acres last year. Of the total area, 1,361,042

acres were sown under Punjab-American varieties and the rest under *desi* cottons. Both the total acreage of cotton and the acreage of Punjab-American varieties constitute fresh records for the province. The crop also established a record of production during the year and never in the previous history of the cotton crop in the province has there been such an outturn. The 1935-36 crop produced the then record of 1,371,600 bales which was 1½ lakh bales more than the highest outturn in any previous year. The present year, however, outstripped last year's high outturn by another lakh of bales and produced a new record crop of 1,467,997 bales.

The whole of the area under Punjab-American cotton is grown under varieties introduced by the Agricultural Department. Amongst the improved Punjab-American cottons, certain newly introduced varieties must be reckoned on a commercial scale in the future. L S S, which is a selection of 4-F possessing the latter's seed characters but having a much better staple and giving very high yields, has become extremely popular, particularly in the Lower Chenab and Lower Jhelum Canal Colonies, in spite of the fact that it is a late cotton and requires a late irrigation if the best results are to be obtained. It is estimated that the area sown under this variety at the end of the year 1936-37 was not less than 150,000 acres. Again the new early strain of Punjab-American cotton, 43-F evolved by the Department and approved for issue three years ago, has gained great popularity in the northern part of the Lower Bari Doab Colony and on inundation supply canals. It is believed that the area sown under this variety at the moment is not less than one lakh acres. The area under K T 25—a selection of 289-F made by the British Cotton Growing Association, Khanewal (and now to be known as 289 F K 25)—is increasing annually.

Of the one-and-a-half million acres under *desi* cottons in the Punjab, it is estimated that about one million acres consisted of the various improved varieties which the Department has distributed. In this connection it is of interest to note

that the latest selection of Mollisoni, known to the Department as Mollisoni 39, is spreading so rapidly that the whole *desi* cotton crop of the Canal Colonies will soon consist almost exclusively of this variety.

" Jubilee cotton ", a cross between Mollisoni and Million Dollars, is exceedingly promising.

SIND. During the year under report, the area under cotton cultivation in Sind was as under :—

	Acres.
Tharparkar District	361,285
Hyderabad District	243,926
Nawabshah District	253,389
Other Districts	54,934
Khairpur State	63,299
Total .	976,832

It will be interesting to note that the area under cotton cultivation is nearly three times greater than what it was prior to the opening of the Barrage Canals. The rapid increase is due to the perennial supply of water and higher outturn obtained from this crop.

It is anticipated that at no distant date the area will be 1,000,000 acres. Out of 976,832 acres under cotton, American varieties occupied an area of 568,588 acres and the rest was under *desi* variety.

It has now definitely been established that the long-stapled Sind-American cottons, *viz.*, Sind-Sudhar (289F-1) and 4F-98, can successfully be grown all over the Left Bank areas replacing other types, which are much inferior in yield, staple-length and spinning value as compared to the improved varieties mentioned above.

Sind N R, *i.e.*, improved Sind *desi*, proved to be superior in yield to the ordinary Sind *desi* in Nawabshah district and a portion of Hyderabad district. Hence the area under this variety has considerably extended in these districts where it is sown as a standard *desi* cotton. These results have given great

impetus to cultivators to grow the improved varieties and the area under such cottons is on the increase every year.

Cotton cultivation in non-cotton-growing tracts. The main object of this work was to introduce cotton cultivation in areas, *e.g.*, Moro and Kandiaro taluks of Nawabshah district in the Indus Left Bank tract, where this crop was more or less non-existent before the opening of the Barrage Canals. Demonstration plots were selected on zamindari lands where Sind N R (*desi*) and 4F-98 (Sind-American) were grown side by side. The yields obtained were so satisfactory that during the year 1936-37 the total area under cotton cultivation in these tracts was about 60,000 acres, whereas during the year 1931-32 it was only 2,830 acres.

Seed distribution. Special attention was given to the distribution of seed of improved long-stapled varieties of cotton on the Indus Left Bank with the object of establishing, as early as possible, a compact block of long-stapled cotton of at least 300,000 acres.

The table below shows the actual quantities of seed distributed during the year under report :—

	Maunds.
Sind-Sudhar	21,586
Egyptian	812
Sind N R	3,658

During the decade prior to the opening of the Lloyd Barrage Canals, the annual area under cotton cultivation in Sind averaged slightly over 300,000 acres with an average outturn of 100,000 bales. With the advent of Barrage Canals, on account of early and assured water supply and increased interest in cotton-growing, the area increased to 982,007 acres (including Khairpur State) in the year 1936-37 with an approximate yield of 517,945 bales of cotton. The area under Sind-American cottons was 561,206 acres in 1936-37 as against 384,415 acres in 1935-36. It is evident that the development of cotton cultivation in Sind is tending more and more towards

the expansion of an area under superior types of American cottons for the cultivation of which irrigation and soil conditions in large tracts of the Barrage areas are eminently suitable.

Three main classes of cotton. Three main classes of cotton have been found to be successful in Sind, *viz.*, (*a*) Sind *desi*, (*b*) Sind-American, (*c*) Imported Egyptian and Sea Island cottons.

Among each of these three main classes, the development of agriculture in Sind, has, by botanical selection, evolved improved strains which on account of better yield, high ginning outturn or superior quality, are suitable for extension in general cultivation in the different cotton-growing tracts of the Barrage areas.

Extension and pure seed multiplication. The pure seed extension scheme is based on " Unit " system, each unit representing a final area of 25,000 acres under one improved variety. In this scheme, which reached its final stage in 1936, the programme adopted for multiplication and distribution of pure seed consists of five progressive stages, *viz.*, (1) seed patch 2½ acres, (2) increase block 25 acres, (3) field-scale plantings 250 acres, (4) village groups 2,500 acres and (5) district groups 25,000 acres. The first three stages are under departmental supervision. The last two stages are being arranged through selective growers. Ten such units were started in the beginning to supply seed to different cotton-growing tracts, but on account of tremendous increase in area under cotton cultivation, especially under medium long-stapled cottons, the number of units has been increased to twenty-four; five units for *desi* cotton, eighteen units for improved Sind-American and one unit for high quality cottons.

The produce of all the stages of the seed multiplication scheme was ginned under the supervision of the Agricultural Department and 30,104 maunds of seed of improved strains evolved by the Agricultural Department were distributed for sowing in the year 1937-38.

Selection work within Sind and Punjab-American cottons was continued with the object of obtaining strains which can stand late sowing, *i.e.*, after 15th May, and which are resistant to jassid attack and red leaf. Certain selections made in Sind 4F variety were very promising, the best of these possessing a staple length of 25·9 mm. and high ginning outturn of 35·7 per cent, in addition to being hardy and resistant to disease. Work on imported varieties of cotton was continued and the improved strains of the African A-12 type withstood jassid attack and red leaf disease fairly well. This strain maintained its useful characters of excellent opening of bolls, high ginning and long staple. Field-scale tests of this cotton in comparison to Sind-American cottons have been laid out.

CENTRAL PROVINCES AND BERAR. The production of medium or long staple cottons that would spin higher counts than 20's is being aimed at in accordance with the mutual policy of the Indian Central Cotton Committee and the Agriculture Department; the object is to oust the existing coarse cottons of these provinces by varieties that can compete in the world market.

The period under review witnessed a further extension of V-434. There were some 20,000 acres under it during the year and once again it proved the best all-round strain with remarkable adaptability to varying climatic conditions. Another characteristic revealed by this cotton was the tenacity of its burst bolls to withstand heavy rain and wind without dropping on the ground like coarser varieties. This cotton has also maintained its high spinning capacity. Out of a number of samples of different strains sent to the Technological Laboratory, Matunga, to be tested, V-434 gave the best spinning performance: it was adjudged suitable for spinning up to 33 standard warp counts. In the field the yields during the last four years on the Akola Farm have been 589, 635, 475 and 589 lbs. per acre, respectively. Twenty-three bales of first quality, Akola Farm V-434, were sold to the Empress Mills at

Rs. 230 per *khandy* (two bales) when Broach was quoted at Rs. 215. The premium obtained for improved cottons when compared with previous years was extremely low, but this was due to unusual market conditions in Bombay as a result of an attempt to corner Broach and a low demand from local mills due to strikes. It must, however, be realized that as the area under V-434 expands, the premium for the superior quality of lint is not likely to remain at Rs. 30, the average of the previous three years. Still, even at half this premium it would pay the cultivator to grow this cotton in preference to the low grade coarse varieties. The area under V-434 in the coming season is expected to be in the neighbourhood of 200,000 acres.

Two wilt-resisting strains of Bani have been isolated which give spinning performances from 40 to 48, but unfortunately the ginning percentages are low (27 to 28). But until the quality of cotton and not the ginning outturn becomes the base of valuation, there is little chance of extension of the area under such superior types.

UNITED PROVINCES. The general condition of the crop for the year under report was very poor on account of exceptionally heavy rainfall all over the province.

C 520 is rapidly gaining popularity owing to its earlier maturity, hardiness and heavy yield. C 402 was propagated as usual in the Sarda Canal area of Hardoi district particularly in the Bilgram-Madhoganj locality on an area of 2,618 acres.

Cotton survey work financed by the Indian Central Cotton Committee was continued in Bundelkhand and 5,736 single plant collections were made.

Further improvement in C 402 and C 520 is being effected by selection of strains on basis of lint-length and ginning percentage within the supposed pure types of C 402 and C 520.

In view of the possibility of the control of the Pink Bollworm to be shortly undertaken on an extensive scale in the United Provinces, the scope for improving quality of cotton

by introducing and acclimatizing long-staple varieties has considerably increased.

BARODA STATE. Breeding work on the evolution of a strain resistant to root-rot disease, undertaken four years ago as a result of previous studies into the causes of the disease, made further progress during the year. Strains likely to combine resistance to root-rot disease with other desirable economic characters in respect of yield, ginning percentage and staple-length have been isolated and are under tests. With a view to giving an impetus to the extension of pure 1027 A L F cotton in Navsari district, a cotton farm was established at Vesma during the year for raising pedigree seed.

MYSORE STATE. Trials carried out during the year under the Mysore (Doddahathi) Cotton Scheme showed that amongst the standard varieties of the other provinces, no variety was absolutely immune, but M A II, Sind-Sudhar, N T 38 and Co 2 appear to offer the greatest prospect of success.

Varietal trials with several pure strains and hybrids were continued during the year with a view to evolving better yielding varieties for the State.

HYDERABAD STATE. Gaorani 6 strain, evolved under the plant-breeding scheme financed by the Indian Central Cotton Committee, which has proved itself superior to the ordinary Gaorani is being introduced in the State on a large scale. Seed sufficient for sowing 50,000 acres was distributed in Nanded district during the year. Jayawant and Gadag No. 1 seeds were distributed in the Raichur district, as usual. The entomological work under the Hyderabad Pink and Spotted Boll-worm scheme continued on the lines of the previous years. The results obtained so far show that the loss in the yield of the cotton crop due to this pest is no less than 15 per cent of the total crop. The methods of control have been studied and some of these will be tested on a field scale during the next year.

CO-OPERATIVE COTTON SALE SOCIETIES. The number of co-operative cotton sale societies working in the Bombay Presidency was twenty-eight on the 30th June 1937 as against

twenty-seven in the previous year. During 1936-37 the societies sold 655,558 maunds of *kapas* and lint of the total value of Rs. 44,80,279 which was about twice the value of the turnover in 1935-36. In the Madras Presidency nine co-operative cotton sale societies dealt in cotton during the year as against seven in the previous year. The total value of cotton handled by these societies amounted to Rs. 13,22,714 during 1936-37. There were three Co-operative *Adat* Societies working during the year in the Central Provinces and Berar which dealt largely in cotton as against two in the previous year. They handled ginned and unginned cotton of the aggregate value of Rs. 53,884. In the Punjab, nineteen " Co-operative Commission Shops " dealing largely in cotton handled 273,042 maunds of the value of Rs. 20,24,932 during 1936-37. The quantity of produce sold by non-members has been steadily increasing. In the Baroda State, sixteen cotton sale societies worked during the year under report as against twelve in the previous year. They handled 6,760 *bhars* of unginned and 1,967 *khandies* of ginned cotton of the aggregate value of Rs. 6,04,138. A special feature of this year was that the societies were persuaded to sell their cotton through the Marketing Office of the State at Surat. In the Mysore State, there were no sale societies which dealt exclusively in cotton, but one credit co-operative society at Maradihalli in Hiriyur taluk undertook the collection of cotton grown by its members and sold such cotton during the year to the extent of 3,651 maunds of *kapas* and 22½ maunds of lint.

4. Sugarcane

THE area under this crop in India during the year was reported as 4,435,000 acres, which is an increase of about 10 per cent over the area in the preceding year. The total estimated yield of raw sugar (*gur*) was 6,717,000 tons. This was an increase of about 14 per cent over 5,908,000 tons of 1935-36,

The total quantity of sugarcane crushed in modern sugar factories in India amounted to 11,873,780 tons during the season 1936-37 as against 9,801,748 tons in the previous season. The production of sugar direct from cane was 1,128,900 tons compared with 912,100 tons during 1935-36. The all-India average recovery of sugar from cane increased to 9·50 per cent from 9·29 per cent in the previous season. The highest recovery for the season was 11·43 per cent, which is slightly more than the corresponding figure of the last year.

The production of sugar refined from *gur* in India during the season 1936 amounted to 50,067 tons, which represented an increase of 10,964 tons over the production of 1935. Of the total production of such sugar during 1936, 44,135 tons were manufactured by factories which are purely refineries, while 5,932 tons were made by cane factories equipped with auxiliary refining plants. An analysis of the average recovery of sugar from *gur* showed a slight decrease from 56·58 per cent to 55·54 per cent and from 57·83 per cent to 57·23 per cent for the United Provinces and all-India, respectively, during 1936.

Imperial Sugarcane Station, Coimbatore

Improved hybrid cane varieties were produced as usual for outside stations in other parts of India. The varieties Cos 213, 349, 421 and the Sorghum hybrid SC 851 are reported to be promising as mother parents and Cos 331 and 508 as pollen parents. Cos 432 and 331 have shown satisfactory resistance to saline conditions. Co 419 is now considered to be a standard variety amongst thick canes. Work on the intergeneric cross with Imperate (Alang Alang) has been taken up. An interesting cross between sugarcane P O J 213 (*S. officinarum*) and the bamboo (*Bambusa arundinacea* Willd) was made during the year and twenty seedlings were obtained. The hybrids of this intergeneric cross did not show any deterioration even when twenty months old. Cytological work largely consisted of the genetical and cytological analysis of *Saccharum*

in the hope of ultimately bringing its breeding programme in line with that of other crop plants.

Cos 285, 313, 331 and 421 are being used as standard types for future work at Karnal Sub-station. Co 421 gave the maximum yield both of factory cane and of *gur*.

IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI

No experimental work on sugarcane could be undertaken in the Agricultural Section of the Institute owing to the transfer of this Institute from Pusa to Delhi. Work was carried on, however, in connection with the clarification of sugarcane juice by the use of ' active carbon ' in the manufacture of white sugar and cream jaggery by the open pan method. Two per cent of ' active carbon ' is reported to be sufficient for clarification of the juice obtained by this method and *rab* and molasses produced from such juices are purer than those obtained by the *khandsari* (white sugar manufactured by the open pan system) method. The sugar produced by this process is remarkable for its whiteness and brilliance and compares favourably with the higher grades of factory sugar.

The study of mosaic and other diseases and pests of sugarcane was also continued. Experiments were conducted on the transmission of the sugarcane mosaic virus, the effect of chemicals on it, etc. Various strains of red-rot (*Colletotrichum falcatum*) were isolated and inoculation experiments were carried out on different varieties of sugarcane. Several physiologic strains of the red-rot organism have been reported. Observations were made also on seedling diseases caused by *Helminthosporium halodes* and by *Pythium graminicolum*. Work on sugarcane pests was carried out at Delhi and observations were also made at Karnal, Pusa and Coimbatore. Collections of the various species of pests were made and the habits of parasites and predators which prey on them were noted.

UNITED PROVINCES.- Experimental work on sugarcane was continued as usual at Shahjahanpur and Muzaffarnagar.

(a) *Varietal trials.* The results of varietal trials showed that Co 76 and Co 421 are promising as early and late types, respectively. The new canes, Cos 312, 313 and 331, occupy about 18 per cent of the total area under sugarcane.

(b) *Manurial trials.* In these experiments the application of nitrogen in increased doses resulted in a progressive increase in the yield of cane. Applications of more than 100 lbs. of nitrogen per acre affected the purity of the juice adversely. Phosphates and potash also gave a slightly increased yield, contrary to the results of the previous year. Molasses, when applied 1½ to 2 months before planting the seed, increased the yield at both the stations. When applied in combination with castor cake, ammonium sulphate or green manure, molasses showed better results than when applied alone. The application of molasses to ratoon sugarcane at Muzaffarnagar produced higher yields than those obtained either from treatment with farmyard manure or from unmanured cane.

(c) *Chemical investigations.* The data obtained in the laboratory in connection with the utilization of *sanai* (*Crotalaria juncea*) for nitrogen fixation corroborated the findings of the previous two years, *viz.*, that nitrogen continues to accumulate for two to three months after the *sanai* is applied to the soil; it then remains constant for a few months after which there is a gradual decline. The data obtained on the effect of different doses of molasses on denitrification (loss of nitrates) also confirmed the previous two years' findings that denitrification sets in a month after the application of molasses to the soil. Nitrates then continue at a low level for three to four months. Thereafter they accumulate to a greater extent in molasses-treated soil than in untreated land.

(d) *Sugarcane pests.* The ecological study of sugarcane pests and their natural enemies was continued at Muzaffarnagar. Several resistant varieties have been selected as a result of investigations on different cultural treatments. The study of bionomics of some of the parasites indicated ways in which cane pests can be prevented from assuming serious forms

BIHAR. Work was conducted under the following three schemes :—

(*a*) The Sugarcane Research Scheme at Musheri,
(*b*) The Sugarcane Improvement Scheme and
(*c*) The Economic Enquiry into the Cost of Production of Sugarcane and other Crops.

(a) *Sugarcane Research Scheme at Musheri.* Cos 279, 313 and 331 are new types which have been distributed to cultivators recently. The addition of these new types has now made it possible to extend the crushing season of sugar factories in the province. In preliminary varietal trials, Co 508 has been selected from the early group, Cos 371 and 385 from the medium early group and Cos 421 and 520 from the mid-season group. Manurial trials again showed that a dressing of forty lbs. nitrogen in combination with green manure and 50 lbs. phosphoric acid per acre gives optimum yields from sugarcane in North Bihar.

(b) *Sugarcane Improvement Scheme.* Under this scheme new methods of sugarcane cultivation were demonstrated in cultivators' fields and in villages adjoining sugar factories. Seed canes of recommended varieties as well as fertilisers were distributed. The method of manufacturing compost and its use in sugarcane cultivation were also demonstrated. Propaganda work was chiefly concentrated in the vicinity of sugar factories where the effect was most marked.

ORISSA. (a) *Varietal trials.* Cos 313 and 349 were tried against Co 213 in the early group and Cos 331 and 421 against the same variety in the mid-season group. Co 213 is reported to have withstood drought and water-logging better than Co 313 but not so well as Cos 421 and 331. Co 421 has proved to be an all round good cane. Co 349 is a very early type suitable for well-drained loamy areas. Co 331 has not been found suitable for the manufacture of jaggery and *rab*. B 247, once largely grown in the Ganjam district, is being replaced by Cos 213 and 285, the former of which now occupies 80 per cent of the total sugarcane area in the province.

(b) *Manurial experiments.* Soils in Orissa, except in Angul and Sambalpur areas, are generally deficient in phosphates. An experiment was, therefore, carried out to study the effect of the addition of variable quantities of nitrogen and phosphoric acid. Cos 213 and 331 were used for the trial. Co 213 showed better results than Co 331 and an application of 60 lbs. nitrogen *plus* 75 lbs. phosphoric acid was found most economic.

(c) *Flood-resisting canes.* As a result of an experiment at Kujang Farm which is situated in the flooded area, Co 285 proved to be the most resistant type to flooded and water-logged conditions. Co 421 showed similar qualities at the Cuttack Farm.

PUNJAB. (a) *Varietal trials.* As a result of continued testing for some years, Cos 313, 312 and 285 are recommended for general cultivation as early, mid-season and late canes, respectively. Co 312 is a very heavy yielding variety, but as it lodges very badly on rich soils it is recommended for soils of average fertility. It may be sown either two feet apart on the flat or in trenches which are ridged up before the beginning of the rains. This cane is liked by wild animals and is damaged considerably in Karnal and Rohtak districts. Co 285 is the most favoured variety and covers the largest area of any of the Coimbatore canes in the province. New promising varieties under trials are Cos 371, 385, 392, 395, 396 and 421. The last appears to be an all round good type.

(b) *Cultural trials.* Final year irrigation trials have indicated that Co 312 can withstand drought better than Co 285. Co 313 requires more irrigation for optimum growth than Cos 213, 223, 281 and 290, but can withstand drought better than these types. Investigations into the appropriate time of planting cane indicated that the month of March was the most suitable period. Late planting affects the germination and the general growth of the crop adversely. No advantage was obtained by planting in autumn (September) as growth is arrested soon after germination owing to the severe cold in winter.

(c) *Manurial trials.* Trials were carried out with different doses of nitrogen in the form of *toria* (*Brassica napus* var. *dichotoma*) cake, sulphate of ammonia and farmyard manure. The results indicate that (i) the increase in yield is not proportionate to the increase in the dose of nitrogen and (ii) a combination of *toria* cake, ammonium sulphate and farmyard manure is more economical than farmyard manure alone.

MADRAS. At Anakapalle, in a varietal trial, Co 419, which showed the best results, yielded fifty-five tons of cane per acre. In manurial trials, poorly fertilised short crop used as seed material and planted in a field which received two-thirds the normal dose of manure gave the maximum yield, while the richly fertilised short crop planted in a normally manured field gave the lowest yield. In an experiment to compare the relative effects of molasses, ammonium sulphate, groundnut cake and green manure (*Phaseolus trilobus*) applied on a nitrogen basis of 26, 52 and 78 lbs., the application of 26 lbs. nitrogen as ammonium sulphate or groundnut cake or molasses and of 78 lbs. nitrogen as molasses gave similar yields. Higher doses of molasses did not result in an increased yield. In irrigation trials, Co 419, whether planted early or late, showed the best results, while Co 373 gave the poorest.

At Samalkota, Co 421 gave the highest yield of fifty-five tons of cane per acre, Co 213 gave forty tons. In an experiment laid out in swampy conditions, out of three varieties tried (Cos 213, 285 and 281), Co 213 gave the highest yield. It was followed closely by Co 285. In a varietal trial of nine varieties, P O J 2878 was found to be the richest and earliest cane. In regard to earliness, the order of merit of other varieties after P O J 2878 was Cos 422, 419 and 425.

At Palur, in a trial of nine varieties on garden lands, Co 419 was found to be the best variety. It gave a yield of sixty tons of cane per acre. It also showed better results than other varieties on wet lands. The manurial experiment started in 1932 was concluded during the year under report. Two hundred pounds of nitrogen as cake and ammonium sulphate,

together with one hundred pounds of phosphoric acid and fifty pounds of potash gave the best yields.

At Gudiyattam, in a varietal trial, Co 419 yielded sixty-nine tons of cane per acre as compared to twenty-five tons obtained from J 247.

BENGAL. In the pre-final tests, Cos 508 and 518 have proved to be promising canes with good field habits and fair tonnage. The juice analysis early in November showed a purity of more than ninety per cent. Co 371 is also reported to be promising as a high-yielding late cane. In a final test of early, mid-season and late varieties of canes, Co 381 has proved to be definitely early ripening. It gave a purity of eighty-six per cent. on 1st October. It is, however, not a good yielder. Co 285 is a better yielder than Co 381, but it is not so early ripening. Of the mid-season canes, Cos 270 and 313 are good yielding varieties but they are liable to lodge. Amongst late canes, Cos 421, 408 and 243 are good-yielding types; the first is the most promising.

BURMA. (a) *Varietal trials.* At Pyinmana Central Station, P O J 2878 has been reported to be the best yielder. It gives a high sucrose content when grown with two cwts. of sulphate of ammonia in sandy loam soils. P O Js 2878 and 2727 are very popular and are spreading rapidly. In a similar experiment on similar soil with five of the newer and thick Coimbatore seedlings, Co 419 proved best as regards both yield and sucrose content. It was followed by Co 423, which is a vigorous thin cane.

(b) *Manurial experiments.* When green manuring with sunn-hemp was substituted for the local practice of growing sesamum before sugarcane, an increased yield of 3·59 tons of cane per acre was obtained. In another experiment sixty pounds of nitrogen applied as sulphate of ammonia gave an increase of 11·34 tons per acre.

In an experiment to determine the best method of planting, no difference was observed in yield with either pit or furrow

planting. There was a saving of Rs. 8 per acre in the cost of planting by the former method.

ASSAM. (a) *Varietal trials.* The varieties Cos 419, 364, 408, 411, 412 and 413, which were reported to be outstanding canes last year, have maintained their reputation, each giving a little more than forty tons of stripped cane per acre. Other promising canes are Co 407, 410 and 421. The last named yielded more than fifty tons per acre. P O J 2714, introduced through Coimbatore, is also proving fairly popular in the province. Cos 290 and 213 are suitable for poorer soils and P O J 2714 for areas where intensive cultivation is possible.

(b) *Manurial experiments.* It has been found that nitrogen applied in the form of organic manure is more suitable for sugarcane than when added as an artificial fertilizer. The effect of phosphate was not significant at all, but potash gave a significant increase. Liming the acid soils of Assam has had no marked effect on the yield of sugarcane. Green manuring alone was not found to be so effective as in combination with farmyard manure.

(c) In cultural trials, three feet spacing between rows of cane was found to be decidedly better than four or five feet spacing. A space less than three feet is not suitable for proper intercultivation operations. Three feet spacing generally is suitable for thin varieties and four feet for thick varieties. January is reported to be the best time for planting sugarcane.

Experiments were conducted for the last six years to find out a suitable method for storing *gur* (raw sugar) as it does not keep well through the monsoon. As a result it has been found that *gur* stored in pots which are dipped in melted paraffin previous to storage keeps well in the rainy season.

BOMBAY. (a) *Varietal trials.* In the final varietal trials of January-planted crop, Cos 419, 413, 421 and 426 out-yielded P O J 2878 and Pundia both in tonnage and sucrose content. For October planting, Cos 407, 408, 413 and 419 have been found more suitable. Co 419 has proved to be the best ratoon cane. Amongst new varieties, Co 434 is the most

promising. Sugarcane-sorghum hybrids—Cos 352, 353 and 356—planted either in January or February did not mature even in nine months. In an experiment with six varieties, planted in January and February with the object of studying keeping qualities in the field from the twelfth month onwards for a period of four months, it was found that Cos 290, 360, 413 and 419 kept well till the end of March but dropped in quality from April onwards. In the Dharwar, Poona and Deccan Canal areas which grow thick canes, Cos 419, 360 and 417 are proving useful. The areas represented by the districts of Nasik and Surat grow, in addition to canes of the thick type, medium canes such as Cos 290 and 213, P O J 213 and indigenous canes of the Sunnaballe group like Khadya.

(b) *Agronomic experiments.* Physiological studies of the sugarcane plant in relation to its water and mineral intake, supported by replicated experiments in the field, indicated that (i) it is useful to apply phosphates at the time of planting, (ii) the dose of nitrogenous top-dressing and the spacing between the rows should be increased in order to replenish the soil deficiency, (iii) with a nitrogenous top-dressing, 95 acre-inches irrigation is the optimum while 70 acre-inches irrigation is insufficient, and 135 acre-inches is definitely harmful.

SIND. *Varietal trials.* Cos 270 and 313 are reported to be the most suitable varieties. They are followed by Cos 281, 244, 213, 313 and P O J 2878. The last three suffer from susceptibility to borer attack. Efforts are being made to spread the cultivation of Co 213 in Karachi, Dadu and Larkana districts. Cos 270, 281 and 312 have been found to be early maturing canes. February was found to be the best time for planting sugarcane. October planting was definitely harmful as it increased sugarcane pests.

NORTH-WEST FRONTIER PROVINCE. The famous Peshawar Paunda cane, owing to its liability to disease, frost and animal attacks, is being replaced by Co 290, which is more satisfactory in all the three respects though comparatively poorer in the quality of its *gur*. It is expected that the latter variety will soon

occupy about 70 per cent. of the total sugarcane area. Of the new introductions, promising varieties are Cos 285, 412, 365 and 361. Co 285 has been found to be better than Co 290 for autumn planting.

In a manurial experiment to study the effect of ammonium sulphate, potassium sulphate and superphosphate, alone or in combination with one another, following a basal application of *shaftal* (*Trifolium resupinatum*) ploughed in and a top-dressing of eight cart-loads of farmyard manure, one cwt. of ammonium sulphate *plus* one-and-a-half cwts. of potassium sulphate *plus* three cwts. of superphosphate per acre gave the highest yield. With a similar basal application, three cwts. of *shora* bone-meal gave better results than a similar weight of blood manure. An experiment was also conducted to ascertain the manurial value of farmyard manure and compost in combination with the fertilisers following a basal dressing of eight cart-loads of farmyard manure with six hundred pounds of *shora* bone-meal showed the best results.

Four feet spacing of sugarcane in trenches was found to give better yields than three feet spacing on the flat.

CENTRAL PROVINCES. Cos 312 and 313 show promise near Chhindwara and Waraseoni and Co 237 in the neighbourhood of Jubbulpore. Co 219 is losing its popularity owing to its liability to red rot. New importations from Coimbatore are on trial in various experimental stations.

The dry method of planting has been found to be economical and advantageous at the Government Farm, Bilaspur.

5. Jute

THE total area estimated in the four provinces of Bengal, Bihar, Orissa and Assam in 1937 was 2,819,000 acres as against 2,885,000 acres in 1936, showing a decrease of 36,000 acres. The yield in the year 1937 was estimated at 8,496,000 bales as against 9,515,900 bales for 1936, a decrease of 1,019,000 bales. As against the finally estimated yield for 1936 of 9,600,000 bales, 105·84 lakhs of bales arrived in Calcutta alone,

while taking the exports from Chittagong and direct consumption upcountry, the total crop must have been about 110 lakhs of bales.

The jute restriction scheme was in operation in Bengal during the year under review, and while it may not have effected any actual reduction in area, it certainly had some effect in preventing an undue increase. But there was no attempted restriction in Bihar and Assam, and undoubtedly in these provinces the jute area has increased considerably in the last few years. A survey by the Government of Bihar of the jute area in Purnea district during 1936 showed this to be 450,000 acres instead of the 200.000 acres reported in recent forecasts. Similar work is being done in Assam and here also it is already evident that the true figures are much higher than those shown in the forecast.

The season was on the whole very favourable to the jute crop and the crop harvested in 1936-37 was about 110 lakhs of bales, and the effect of this size of crop certainly would have been a great fall in prices but for the fact that during the year the world demand for jute was abnormally high. During 1936, the restrictions in the manufacture of jute by members of the Indian Jute Mills Association were removed in successive stages so that the output of the mills increased very rapidly and the prices of the mill products remained low. Partly on account of the low prices of hessians and gunnies and partly on account of greatly improved world demand for jute owing to the recovery of world trade, the output of the mills was sold as rapidly as produced, and the export of raw jute also reached a very high level. The total exports of jute and jute products reached 1,778,000 tons and was even slightly greater than that of the record year 1929-30. Chiefly owing to this very large demand, the price of raw jute remained comparatively steady throughout the year. The price of raw jute ' firsts ' per bale of 400 lbs. was Rs. 35 early in the year, and though in July it fell below Rs. 30, it rose again to Rs. 35-12 in December and finished at Rs. 36-8.

The Department of Agriculture, BENGAL, continued its work on the testing of promising selections both of the *Capsularis* and of the *Olitorius* varieties. Work was also done in the retting of jute, particularly with regard to sizes of bundles and depths to which bundles should be sunk. The Government restriction campaign, however, interfered seriously with the departmental work of distribution of seed of the new improved varieties. It is expected that the bulk of this agricultural research work will be taken over by the Indian Central Jute Committee when the latter has established its Agricultural Research Laboratory at Dacca.

During the year under review, the INDIAN CENTRAL JUTE COMMITTEE, financed by grants from the Government of India, was constituted by a resolution of that Government. The Committee held its first meeting in February, 1937, and drew up a programme of work which included the following items:—

(1) An enquiry into the marketing and transport of jute and its products.
(2) Agricultural research.
(3) Arrangements for the supply of seed of improved varieties.
(4) Technological research, primarily into the characteristics of the fibre, and their connection with spinning quality.
(5) Improvement of the jute forecast.
(6) Collection and distribution to those in need of them of statistics and information on the production of, and demands for, jute and jute products.

Arrangements were also made for a special jute staff to be recruited and posted to the jute districts to assist the central body in these various lines of work and to assist the cultivator by the dissemination of information of value to him. The Committee has been pushing on with all the preliminary arrangements for carrying out these schemes of work, such as the provision of buildings, equipment and staff for its research work and the collection of the information required. The

Government of India approved of the Committee's programme of work and made it a grant of Rs. 5 lakhs for the year 1937-38. The Secretary of the Indian Central Jute Committee is Mr. A. P. Cliff, B.A., I.A.S., and the office of the Committee is at 1, Council House Street, Calcutta.

Later in the year, the Indian Jute Mills Association opened a laboratory under the control of its Research Department for research on the various aspects of processing and manufacture of jute. There are thus two Technological Research organisations working on the technology of jute, that of the Indian Central Jute Committee concerned with fibre characteristics and spinning quality but also vitally interested in the possibilities of new uses for jute, and that of the Indian Jute Mills Association concerned with processing and manufacture of jute but also interested in new products. The two organisations consult on their research programme to avoid unnecessary overlapping.

6. Other fibres

Hemp. The 'New Hibiscus' (*Hibiscus cannabinus* L. and *H. sabdariffa* L.), multiplied at Pusa from an accidental introduction, has proved a great success. It has been favourably reported upon by the Madras and Bengal Agricultural Departments. It reaches its full growth on a much smaller rainfall than is required for jute; its fibre, though not so fine as jute, compares well with it. A hybrid between the 'New Hibiscus' and another Pusa variety of *Hibiscus* has been found to surpass the former in the quality of fibre, whilst retaining the other desirable characters of the variety.

Colour of stem, petiole, corolla, calyx, nature of leaf-lobe, hairiness of stem, etc., are some of the characters of which the mode of inheritance has been worked out at the Imperial Agricultural Research Institute, New Delhi. The different colours on the stem, leaf-veins and calyx were found to depend upon one, two or more factors. Red colour in the stem of whatever kind was associated invariably with colour in the eye of the corolla and the capsule but its expression depended upon

yet another factor. Narrow leaf-lobe and yellow corolla were dominant monogenically to broad leaf-lobe and white corolla. Hairiness of the stem behaved as digenic character giving a ratio of 15 hairy (various grades) : 1 non-hairy.

Samples of fibre of ' New Hibiscus ' and of a fixed hybrid between ' New Hibiscus ' and the variety *albus* of *H. sabdariffa*, grown and retted under identical conditions, were submitted to the Assistant Fibre Expert, Bengal, for comparative tests. The fibre of the hybrid was reported to be superior to that of the ' New Hibiscus ' in fineness and appearance.

BENGAL. The ' New Hibiscus ' (*Hibiscus sabdariffa* var. *altissima*) was compared with Mesta (*Hibiscus cannabinus*) and it was found that it attained better height and looked better than the local Mesta. The cultivators in the Madaripur Sub-division, where it was tried, are anxious to have its seed to be grown in place of Mesta. The ' New Hibiscus ' is a heavy yielder and if the quality is also found to be superior to Mesta, then it will be a real boon to the cultivators of these parts.

Sunn-hemp (*Crotalaria juncea*). There was a better demand for Indian hemp and exports advanced from 643,000 cwts. valued at Rs. 60 lakhs in 1935-36 to 769,000 cwts. valued at Rs. 69 lakhs, showing an increase of 20 per cent in quantity and 15 per cent in value. The United Kingdom increased her purchases from 168,000 cwts. to 243,000 cwts. and Belgium from 200,000 cwts. to 236,000 cwts. Exports to Italy and the United States of America also improved from 11,000 cwts. and 24,000 cwts. to 32,000 cwts. and 31,000 cwts. respectively. On the other hand, Germany and France reduced their takings to 47,000 cwts. and 54,000 cwts. from 68,000 cwts. and 67,000 cwts. respectively in the preceding year.

At the Imperial Agricultural Research Institute, the twenty-two cultures of sunn-hemp obtained by mass selection were handed over to the Botanical Sub-station, Pusa, for final trials. The complex experiment designed to obtain information regarding the best varieties, the correct seed-rate and the best time of sowing the crop for fibre purposes, which was laid down

last year at Pusa by the Botanical Section, is also being continued by the Botanical Sub-station.

BOMBAY. Sunn-hemp being a self-sterile plant, the relative efficiency for pollination purposes of different species of bees was tested. The idea is to devise a simple method of cross-pollination for multiplying the seed of the wilt-immune strains.

Sunn-hemp was grown in a small plot to attract bees, and the following species were found to visit sunn-hemp flowers: *Megachile anthracena*, *M. lanata*, *M. elizabetha*, *Apis dorsata* and *Ceratina viridissima*. Megachile and Apis were found in great abundance, but Ceratina was rarely seen. Apis was found to be more efficient than Megachile as regards the number of pods formed, but the seeds formed in such pods were poorly developed. The Apidæ are, however, more active than the Megachile bees, which become slack under conditions of captivity. The Megachile bees are on the whole better suited for securing cross-pollination in sunn-hemp since the use of Apis bees is likely to result in sterility or deterioration of a strain after a few generations due to self-fertilisation.

The seed of the wilt-immune strain, D-IX, was multiplied in a large muslin cage, measuring 40 feet × 15 feet. The yield was much reduced due to an attack of insects and heavy late rains. The seed thus produced will be multiplied in the field at Dharwar where there is no danger of contamination as sunn-hemp is not generally grown in that area.

BIHAR AND ORISSA. The selection work on *sanai* (*Crotalaria juncea* L.) undertaken in the *kharif* season of the year 1933 with a view to evolve types of high fibre-yielding capacity coupled with good quality was continued. Simultaneously, preliminary experiments, made for a period of three consecutive years on the extraction of fibres of *sanai* samples collected from representative localities, have shown that the early varieties in general yielded the best fibre, and particularly the fibres extracted out of the Bihar and Mawadah samples were, on examination, reported upon as excellent by the Imperial Institute, South Kensington, London. The study was therefore

restricted to the early varieties alone and as such during the season forty-six cultures were minutely examined and desirable material was collected out of these for future work. It may, however, be remarked in confirmation of previous year's report that cultures from samples obtained from the Santal Parganas have again proved to be the earliest in point of flowering and maturity of seeds. Selfed single plant seeds for cultural study are being obtained by the new method of controlled pollination in *sanai* evolved in the Botanical Section at Sabour.

A small grant for a period of three years has been sanctioned by the Imperial Council of Agricultural Research for Madras, Bombay, Bihar and Orissa and a larger grant for a period of five years for the Central Provinces. The general programme of work is the same for all the four schemes, subject to variations due to local conditions or to particular recommendations of the Hemp Marketing Officer.

Flax. BENGAL. Fifty-six pounds of Liral Monarch flax seed was imported from Ireland for trial. To find out the localities where the crop seeds freely, several places were selected, representing different types of land. It can be safely inferred from the results so far obtained that, wherever the land retains moisture up to March or wherever irrigation can be resorted to, flax can be successfully grown either for seed or for fibre. There is no evidence yet of seed deterioration, but certain places seem better than others for seed production. An attempt is being made to introduce the extraction of the fibre as a home industry and simple scutching machines have already been devised which will be within the easy reach of everybody. The machine is being further improved and it is expected that it will be perfected in the near future. The Imperial Council of Agricultural Research has sanctioned a grant for investigations into the method of extraction of flax fibre in Bengal. Out of the flax fibre obtained from last year's crop, three samples of retted flax weighing 5 lbs. each were sent to Messrs. Wigglesworth and Co., London, for valuation as well as to find out any defects in the fibre. The reports are encouraging and with

the price quoted for the fibre, flax cultivation is at any rate remunerative. The said Company has also agreed to handle any quantity of flax fibre that will be sent for sale on a commission of 3 per cent on the realised value. Arrangements are being made to test the fibre in a local mill with a view to find out the possibility of establishing a flax mill in this country.

Karnal has been found to be a suitable place for seed multiplication and the Imperial Agriculturist has agreed to grow flax at the Cattle Farm at Karnal in five acres of land during the current year. It is expected that forty maunds of seed will be obtained from this area, over and above that which will be obtained from the experiments in different parts of Bengal.

Sisal Hemp. This was planted in Bengal at the Government Farm, Dacca. The plants attained a good height and were quite vigorous. Extraction experiments on a large scale were undertaken. In one experiment 11 maunds 3 seers of green leaves were crushed in bullock-driven sugarcane mill. This gave a satisfactory outturn of 17¼ seers of clean, white and strong fibre, being about 3·7 per cent of the green weight of the leaves. Experiments are also in progress to make this fibre suitable for brush making, as brush makers import this kind of fibre in large quantities from outside the province.

Rhea. Rhea seed was sown on the Rangpur Tobacco Farm as well as at the Dacca Government Farm. Extraction experiments were also conducted at both the places. Good quality fibre could be obtained, but the method was found to be expensive. Several enquiries were received regarding this fibre.

7. Tobacco

THE total area under tobacco in 1936-37 was 1,211,000 acres as compared to 1,357,000 acres in 1935-36, and the total yield of dry leaf was estimated to amount to 523,000 tons in 1936-37 as against 651,000 tons in 1935-36. The bulk of the tobacco grown is consumed in the country. The exports of unmanufactured leaf was 28·8 million lbs. valued at Rs. 86·2 lakhs.

As usual, the most important outlet for Indian tobacco was the United Kingdom which took 12·9 million lbs. during the year as against 11·7 million lbs. in 1936. The import of cigarettes continued to advance slightly as a result of the revision of duties and in 1936-37 it amounted to 919,000 lbs. valued at Rs. 32 lakhs, against 831,000 lbs. valued at Rs. 28 lakhs in 1935-36. The bulk of the imports came from the United Kingdom which supplied 877,000 lbs. valued at Rs. 30 lakhs. In the preceding year the quantity was 780,400 lbs. valued at Rs. 27 lakhs. Imported unmanufactured tobacco amounted to 3·3 million lbs. in 1936-37 as against 1·9 million lbs. in 1935-36. Imports of raw tobacco were obtained chiefly from the United States of America which supplied 3·1 million lbs. in 1936-37 and 1·5 million lbs. in 1935-36.

The economic work on tobacco in India during the year under review took account of the fact that the greatest opportunity in regard to this crop lay in the production of leaf suited for the cigarette market. Research on the various aspects of cigarette tobacco production, therefore, received most attention. A five-year scheme of tobacco research was sanctioned by the Imperial Council of Agricultural Research and work in connection therewith was started at Guntur in August 1936. Under this scheme, a detailed survey of the tobacco-producing area in Guntur taluk was carried out. The soils on which tobacco is produced can be classified broadly into river-flooded alluvium, red soil and black cotton soil. The quality of the leaf of cigarette tobacco produced on these types of soils was studied. Three cigarette tobacco varieties, *i.e.*, Adcock, Harrison's Special and Pusa H 142, were grown on a large scale and their behaviour in the flue-curing barn was studied.

Leaf-curl of tobacco, which is one of the most serious maladies affecting this crop, was studied at PUSA by the Botanical, Entomological and Mycological sections of the Imperial Agricultural Research Institute, New Delhi. Counts of leaf-curl

plants in plots from monthly sowings of H 142 tobacco showed that the incidence of disease is greatest in the months of October and November, especially in plots where the crop was sown in June and July. Transmission experiments with the white fly (*Bemisia gossypiperda*) were also carried out and the results indicated that leaf-curl could be transmitted from diseased sunn-hemp to healthy sunn-hemp, from diseased sunn-hemp to healthy tobacco and from diseased tobacco to healthy tobacco by means of this vector.

Another series of experiments conducted at Pusa showed that all the five types of leaf-curl are not transmissible through juice.

Progress was made in the co-operative all-India scheme to determine the most suitable areas in which to extend the production of cigarette tobacco. The work under this scheme is complementary to that undertaken at the Tobacco Research Station at Guntur. During the year under review, the three varieties of cigarette tobacco used as standards, *viz.*, Adcock, Harrison's Special and Pusa H 142, were grown at Nadiad (Bombay), Dacca and Rangpur (Bengal), Bhilwal and Farrukhabad (United Provinces), Jullundur and Lyallpur (Punjab), Sabour (Bihar), Nagpur and Bilaspur (Central Provinces), Baroda and Ramol (Baroda) and Warangal (Hyderabad). Samples of cured leaf from the crops grown at these stations were sent to the Imperial Economic Botanist for valuation.

The chief items of work in progress during the year at important centres are given below:—

MADRAS. The Indian Tobacco Association was registered under the Registration Societies Act XXI of 1860 in January, 1937. The Marketing Staff helped the Association in preparing samples of different grades of flue-cured Virginia tobacco.

BOMBAY. Work at the Nadiad Tobacco Breeding Station, Gujarat, included selection to obtain a smaller and thicker

leaf type for the Piliu tract: twenty cultures were retained for further study. Considerable research was done on tobacco-curing. Comparative trials on flue versus sun-curing methods were carried out with the varieties, Harrison's Special and Gandiu No. 6. Much attention was given to the economics of different curing processes and to the matter of securing correct trade valuations for the various products.

BENGAL. During the last four years the area under this crop has increased by over 25,000 acres most of which is under departmental varieties. Some 100 lbs. seed of recommended *desi* varieties was distributed from Government farms during the year and fresh areas have been opened up in parts of the districts of Bakarganj, Hooghly, Noakhali and 24-Parghanas. Small areas of Harrison's Special, Adcock and Pusa hybrid 142 were grown on the two farms at Dacca and Rangpur and altogether nine barns of leaf were flue-cured. The results which aim at producing a yellow coloured leaf suitable for cigarette manufacture were promising. The sales of cheroots at the Dacca Farm amounted to Rs. 1,291 this year as against Rs. 1,268 last year.

PUNJAB. Types 12 and 57 continue to give much higher yields in most parts of the Province than local tobaccos.

On an average of all the trials, type 12 produced an increased yield of 22 per cent over local varieties, whilst the increased yield of type 57 was only slightly less. The latter is the best quality tobacco of all the types in hand. Three varieties of cigarette tobacco, Harrison's Special, Adcock and Hybrid 142, were under experiment at Lyallpur and Jullundur. At both centres the order of merit of these varieties was the same. Harrisons' Special was easily the best. It yielded at Lyallpur 38·1 maunds and at Jullundur 18 maunds per acre of cured tobacco. In the flue-curing experiments carried out under the auspices of the Imperial Council of Agricultural Research, the best quality leaf was obtained from Harrison's Special. Samples of Jullundur cured leaf sent to different

cigarette manufacturing companies for valuation were priced on an average at four annas per pound *ex*-farm.

BIHAR. The August-sown crop was not ready for curing under Sabour conditions till March and the crop which was ready in March also offered some difficulties. To overcome them and have leaves fit for curing early in the season, early sowing from June was attempted during the year. Adcock was found to be the most delicate of all the varieties. About eighty maunds of green leaves in all were cured and the barns were loaded nine times. The cured leaves were graded into three classes and were valued by experts. The results so far obtained show great possibilities of producing properly cured leaves which can be marketed within the country at very remunerative prices.

ASSAM. Trials with the improved varieties Pusa 18 and 28 gave promising results.

SIND. The early sowing of seed, *i.e.*, in the first fortnight of June, and transplantation of the seedlings before the 15th of August gave successful results. The crop grown in this manner matures before frost sets in and thus escapes damage.

TRAVANCORE. Until recently it was not possible to grow tobacco in Travancore but the Government allowed its cultivation last year subject to certain restrictions. The Department of Agriculture started cultivation on a very small scale in the Puliyara Farm. The plants grew well in preliminary trials. During the latter half of the year, a company was registered to undertake tobacco growing on a large scale and since the close of the year this company has planted the first crop on an area of about twelve acres at Edakode.

BARODA. A cigarette tobacco barn to duplicate the State one at Baroda was put up at Ramol on a private farm where Virgina leaf was grown for the first time outside the Government Farm. The results were so encouraging that the owner has decided to put down a larger area in 1937-38 and to erect another barn at his own expense.

8. Oil-seeds

THE estimated area and yield of principal oil-seeds in 1936-37 as compared with 1935-36 are furnished in the following table :—

Crop	1935-36		1936-37	
	Area in thousands of acres	Yield in thousands of tons	Area in thousands of acres	Yield in thousands of tons
Groundnut . . .	5,857	2,258	7,279	2,808
Sesamum	5,664	462	5,562	484
Rape and mustard . .	5,333	957	5,811	976
Linseed	3,457	388	3,594	418
Castor	1,458	121	1,405	128
Cotton	..	1,946	..	2,163

In 1936-37 the production of cotton was 6,008,000 bales and the output of cotton-seed calculated at 0·36 ton per bale may be estimated at 2,163,000 tons. During 1936-37 there has been considerable increase in the production of all oil-seeds, the aggregate production of oil-seeds being 6,977,000 tons as against 6,132,000 tons in 1935-36. The area under all oil-seeds excepting sesamum and castor has recorded a rise which amounts to about two million acres, and even in the case of sesamum and castor, the outturn has actually increased owing to favourable seasonal conditions.

The total exports of oil-seeds have shown a remarkable increase of 72 per cent in quantity and 79 per cent in value, and amounted to 1,155,000 tons valued at Rs. 1,844 lakhs as compared with 673,000 tons valued at Rs. 1,029 lakhs in 1935-36. The exports of groundnuts during the year rose to 739,000 tons from 413,000 tons in 1935-36. Similarly the exports of linseed from India increased by 79 per cent. in quantity from 165,000 tons to 296,000 tons. The purchases of linseed and groundnut by the United Kingdom during 1936-37 were doubled. There was also noticeable expansion in the

shipments of groundnuts to France, the Netherlands, Germany and Italy.

A preference of ten per cent in favour of Indian linseed in the United Kingdom, the levy of import duty on soya beans in the United Kingdom, a 50 per cent reduction in the French import duty on foreign groundnuts, more favourable prices and larger production in India, were the main inducements for larger exports.

Exports of oil-seeds in thousands of tons

Crop	Pre-war average	1935-36	1936-37
Groundnut	212	413	739
Linseed	379	165	296
Castor	114	60	43
Rape and mustard	277	19	38
Cotton seed	240	1	9
Sesamum	119	1	14
Others	102	14	16
Total	1,443	673	1,155

The exports of non-essential vegetable oils increased from 2,358,000 gallons valued at Rs. 36 lakhs to 2,899,000 gallons valued at Rs. 44½ lakhs. The imports of coconut oil, mostly from Straits Settlements and Ceylon amounted to 7·8 million gallons valued at Rs. 91 lakhs in 1936-37 as against 8·5 million gallons valued at Rs. 90 lakhs in the preceding year.

Exports of oils in thousands of gallons

Oil	1913-14	1935-36	1936-37
Castor oil	1,007	1,408	1,515
Groundnut oil	288	291	428
Mustard oil	407	237	252
Coconut oil	1,091	33	14
Other sorts	449	389	690
Total	3,242	2,358	2,899

The shipments of oil-cakes increased from 300,000 tons in 1935-36 to 336,000 tons in 1936-37, the improvement being in all the cakes except linseed cake, the demand for which was less in the United Kingdom on account of her very large purchase of Indian linseed for crushing. The groundnut cake forms 71 per cent of the total exports of oil-cakes.

The Imperial Council of Agricultural Research continued its grant to the Oil Section of the Harcourt Butler Technological Institute, Cawnpore. During the year, the Oil Section dealt with forty-two technical enquiries and drew up twenty-four schemes for the benefit of oil-milling and oil-using industries. Five Diploma course students and two short course students, nominated by the Council, were admitted for training free of all fees.

In connection with the marketing surveys initiated by the Council, 724 samples of linseed and 172 samples of oils were analysed at the Harcourt Butler Technological Institute; the Oil-seeds Specialist, Madras, examined 847 samples of groundnut for physical characteristics and subjected 351 samples to chemical analysis. The results were circulated to the traders and oil millers; and revised provisional standard contract terms were agreed on at the conferences between the marketing staff, traders and millers.

Chiefly, as a result of the finances provided by the Imperial Council of Agricultural Research, research on oil-seed crops is now being conducted on a large-scale. The Council has sanctioned schemes for research work in seven Provinces and States embracing all the important oil-seeds of India, *viz.*, (1) groundnut research in Madras, (2) linseed testing in Bengal, (3) a scheme for improving linseed, safflower, *til* (sesamum) and niger crops in the Central Provinces, (4) a scheme for improving *Brassica* oil-seeds in the Punjab, (5) a research scheme on castor in the Nizams Dominions and (6) a joint scheme for Travancore and Cochin for the investigation of coconut root and leaf diseases.

A brief summary of the work done during the year is given below.

Groundnut. The area under groundnut in 1936-37 advanced remarkably to 7,279,000 acres from 5,857,000 acres in the preceding year, showing an increase of 24 per cent. The principal areas under this crop were Madras with 3·5 million acres; Nizam's Dominions with 0·95 million acres; Bombay States with 0·88 million acres; Bombay with 0·87 million acres and Burma with 0·72 million acres.

The price of machine-decorticated groundnuts in Madras which was Rs. 33-11 per candy of 500 lbs. on 2nd April, advanced during August to Rs. 40-12 and thereafter it declined to Rs. 33-11 on 30th October. The price appreciated to Rs. 39-14 on 2nd January and in March it was at Rs. 36-12. The average price of Coromandel groundnuts in 1936 for near shipment to the United Kingdom and Northern Europe was £14-10 per ton compared with £14-5 in 1935.

MADRAS. The improved variety A H 25 was tested in fifty-two centres and proved superior at all but two of the centres. During the year, 61,150 pounds of improved seed was distributed. Demonstrations for increased seed-rate and improved methods of lifting the crop were carried out.

The plant-breeding work on groundnuts was carried on at the Tindivanam Station. A collection of eighty-seven varieties was maintained for the benefit of research workers in the Empire.

The germination of pods in a standing crop of the bunch groundnut is a common occurrence; it was found that the solution of this problem lies in the introduction into the bunch varieties, by crossing, of some qualities from the spreading varieties. As an aid to the breeding programme, the relative susceptibility of different varieties to *Rhizoctonia* wilt was determined.

Since, in the Madras presidency groundnuts are mostly sold by measure, it was found necessary to add the weight-volume relationship to the list of commercial characters

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(shelling percentage, oil and free fatty-acid content) to be kept in view when selecting the types. Of the sixty-five spreading pure lines under intensive trial, six were found to yield significantly more than A H 25. A bunch pure line, A H 218, has given a significant increase of 14 per cent over the control. With a view to bring together valuable economic characters such as high yield, high oil-content and early maturity, thirty F_1 generations of crosses were raised and 303 selections were made from F_3 and F_4 progenies.

In BOMBAY, the varieties K-1 and K-3 were found promising. In SIND, it is found that oil-seed crops possess a wide range of sowing periods which enables the cultivator to make full use of the perennial irrigation water. Groundnut is found to do well in the Karachi and Dada districts, yielding eleven to fourteen maunds per acre. June sowings, and 18″ spacing for the bunch, and 24″ spacing for the spreading variety, are found most economical at the Sakrand Station. From the collection of all-India varieties, Sagtur Bangalore No. 3, Sakrand Local No. 47, Dharwar II No. 44 and Dhulia No. 74 were found to be the most suitable varieties for Sind. The percentage of oil in Sind nuts is rather low, the spreading varieties yielding only 37 to 43 per cent oil as compared with 50 for most of the nuts grown in other provinces of India. In this respect, the Spanish varieties are better as they yield 46 to 49 per cent of oil in Sind.

In the CENTRAL PROVINCES, the improved variety A K 12-24 is fast replacing the local oil-yielding varieties, on account of its hardy nature and dormancy of seed. A new strain A K 8-11 has been evolved for domestic purposes; it is easier to harvest and yields 5 per cent more seed on shelling than the older type A K 10. Over 28,000 lbs. of improved seed were distributed during 1936-37.

In BENGAL, types A H 18 and Gudiyatham, both from Madras, and Satara No. 2 proved superior to the Red Bunch Pollachi. In the PUNJAB, where the groundnut was first introduced in 1931, the crop is becoming increasingly popular and

varieties A 2, B-1 and D-3 are being multiplied. In MYSORE, ten varieties of groundnuts were found superior to H G 1; selection and hybridization are in progress. In the NIZAM'S DOMINIONS, experiments have shown that an enhanced seed-rate of 60 lbs. is more remunerative and that a good *rabi* crop can be grown with the December sowing of Kanke No. 17 variety. The groundnut crop is being introduced in ASSAM and COCHIN State.

Sesamum. The main sesamum growing provinces are :— Burma with 1·4 million acres, Madras with 0·8 million acres and the Nizam's Dominions with 0·5 million acres.

In BURMA, three varieties proved superior to the others. The second generation hybrids between the Palestine and the Burmese varieties are under examination for their oil-contents. In MADRAS, at the Tindivanam Station, varieties from Anakapalle and Giddalore yielded significantly more than the controls. The mode of inheritance of the seed-coat colours was worked out.

In the CENTRAL PROVINCES, investigations on the stem-bending disease suggested the possibility of the disease appearing on account of the injection into the stem of some toxic substance by an insect. Comparative trials with types and varieties were in progress in the Central Provinces, Sind, Mysore and Baroda.

Rape and Mustard. The area under this crop during the year rose to 5,811,000 acres. Over 50 per cent of the area under this crop is in the UNITED PROVINCES. The PUNJAB with an area of 949,000 acres is the next important rape and mustard growing province.

The Imperial Economic Botanist studied the extent of self-sterility in *sarson* (*Brassica campestris* L. var. *sarson*) and *toria*, and crosses were made to investigate the problem of self-sterility which is very closely linked with the breeding programme. In the PUNJAB, about 500 maunds of seed of a mass-selected improved strain of *toria* were produced. Continuous mass selections in brown-seeded *sarson* have resulted in the

isolation of Selection-A which is outstanding in its performance in zamindari areas. The mustard type O B 1 has proved the best, as it is drought-resistant, high yielding and also valuable as a fodder crop in Rawalpindi. The Punjab Oil-seeds Botanist is testing the suitability of different breeding methods for the various *Brassica* crops. As a result of hybridization between self-sterile yellow *sarson*, and self-fertile brown-seeded *toria* and *sarson*, extensive data have been collected on the sterility and inheritance of characters. The study of cross-sterility in *toria* and *taramira* has facilitated the grouping of intra-sterile and inter-fertile types.

In BIHAR at Sabour, the types of mustards have been fixed and described, and the study of the mustard hybrids is in progress. *Toria*, to escape the frost in SIND, has to be sown at a particular time. Two early-maturing types and two late-maturing types are promising, but the former yield 42 per cent oil as compared with 39 per cent for the latter. Four promising varieties of yellow-seeded *sarson* contain 2 to 4 per cent more of oil. Early maturing varieties of *sarson* are reported to escape the peak of aphis attack. In mustard, selection No. 228 Jhatpat has been found to combine high yield with early maturity.

In BENGAL, several pure types of mustard with good oil-content have been produced; and preliminary studies show that neither in oil-content nor in the quality of oil the United Provinces mustards are superior to the evolved Bengal types.

Linseed. The year under review showed a further increase in the area under linseed from 3,457,000 acres in 1935-36 to 3,594,000 acres. The principal linseed-growing areas are the Central Provinces and Berar (1,131,000 acres), the United Provinces (898,000 acres), Bihar (550,000 acres) and the Hyderabad State (468,000 acres).

The Imperial Council of Agricultural Research continued to issue weekly circulars containing useful information regarding the linseed trade in India and abroad. The prices of linseed bold at Bombay, which opened at Rs. 7-3-6 per cwt. on

2nd April rose during July and August to Rs. 8-15. Thereafter the prices declined, and appreciable recovery was felt only in March, the price being Rs. 8-5 on 25th March.

At Pusa and Karnal stations, rust-resistant cultures obtained from crosses between indigenous varieties and foreign rust-resistant varieties were grown, and further selections were facilitated by the considerable incidence of rust. Seven hybrids were compared with type 12, but the latter proved superior to all the hybrids except two. In the production of colour in the petal, three genes were found to be concerned and the character " yellow-tipped " proved recessive.

In the CENTRAL PROVINCES, the aim is to produce high yielding, early-maturing rust-resistant forms of linseed, and considerable success has been achieved by means of hybridization. The two most prominent strains are the products of the crosses between E B 3 and Punjab linseed. This success is being followed up by further hybridization between E B 3, Pusa type 12 and European flaxes, and some of the F_8 cultures are promising.

In BIHAR, wilt and rust-resistant selections were made from the sixth generation of hybrids between the Sabour wilt-resistant linseed-6 and Pusa type 12. In the PUNJAB, three local types (5, 11 and 23) gave significantly higher yields than the Pusa types.

At the Berhampore station, BENGAL types No. 26 and No. 52 proved superior to some of the non-Bengal types. At the Dacca station, 124 types of Pusa pure-lines, 105 Pusa hybrids, 74 Dacca types and 6 Cawnpore types were tested. The breeding of linseed at Poona was financed by the Sir Sassoon David Trust Fund. Out of 148 line-cultures, 48 were found to combine in them better yield, higher oil-content and superior drying quality of oil. Since all the BOMBAY linseeds are brown-seeded, it is felt that the character of drying quality of oil requires to be introduced through hybridization with white or yellow-seeded foreign types. A selection from the local Kundewadi material gave 13 per cent higher yield. Varietal

trials are in progress in ASSAM and in SIND. In Mandalay, BURMA, the crop did not appear to be a promising one.

Castor. The principal castor-growing areas are: Nizam's Dominions with 781,000 acres, Madras with 264,000 acres and Mysore with 103,000 acres.

In the NIZAM'S DOMINIONS, selection work in castor was continued with a view to evolve varieties with high yield and high oil-content. The basic stock consists of 204 single-plant cultures with a high proportion of female flowers as an inherited character and 230 cultures derived from all-India samples. Out of these, sixteen cultures seemed promising. The mass selected seed has been distributed.

In MADRAS, twenty-one selections from a cross between " short compact head branching type " and a " long sparse head non-branching type " were tested. One type of castor yielded as much as 61·69 per cent oil, the lowest being 35·63 per cent.

In SIND, the castor plant is able to withstand a fair amount of *kalar* in the soil. The dwarf types from Viramgam, Surat and Thana did well, as they were less susceptible to the root-rot disease. April-May sowing and $4' \times 2'$ spacing give good yields ranging from ten to twelve maunds per acre. In BOMBAY, type S 20, produced at Nadiad, gives 13 per cent higher yield than the local varieties, and it is therefore spreading rapidly in Kaira and Panch Mahals. The comparative trials of types and varieties are in progress in ASSAM and the CENTRAL PROVINCES.

Coconut. In MADRAS, the breeding programme for the coconut has been taken in hand. The vigour of the seedlings raised from the seeds collected from different seed-centres was on the whole less than the vigour of the seedlings from the nuts from the Kasaragod station. No difference could be made out in the vigour of the resultant seedlings or in the germination percentage of seed-nuts harvested from young, middle-aged or old palms. It was found that the longevity of the leaf in the high-yielding palms was significantly greater than in the poor-yielding palms. For selecting the seedlings in the nursery, the

girth of the seedling proved the most reliable character. It is experimentally found that if a garden is left uncultivated even for a period of two years, the production of female flowers is reduced and consequently the yield. Artificial opening of spadices reduced the yield considerably and the hastening in maturity was insignificant. During the year, 14,535 seed-nuts and 1,511 seedlings were distributed. The investigations into the causes for the root-disease of the coconut are being conducted in TRAVANCORE.

Safflower. At the Dacca Farm in BENGAL, the Pusa types of safflowers thrived extraordinarily well during the dry season. In SIND, Pusa 18 and Dholka 1 types are found to be high yielding and frost-resistant.

9. Tea

OWING to the continued operation of the Tea Control Act, the area under tea has remained practically unchanged during the period under review. The allowable export quota for the year 1936-37 was fixed at 82½ per cent. of the basic year crop by the International Committee. The allowable export quota thus remained the same as in the previous year.

The quantity of tea that was exported during 1936-37 was as follows :—

	Lbs.
North India—by sea	255,551,781
South India—by sea	48,533,653
North India—by land to Iran . .	3,906,641
Total .	307,992,075

By the end of February, 1937, the London stocks had fallen to an amount considerably below that of February, 1936, as shown by the following figures :—

London stocks at the end of February in million pounds—

1934 . . .	283	1936 . . .	262
1935 . . .	298	1937 . . .	206

As might be expected with falling stocks, the average price for tea in London improved as also did the average price for tea sold for export in Calcutta, whereas tea for internal

consumption in India realised a slightly lower average price than in the two previous years.

Average price in pence obtained in the London market :—

1934	13·27
1935	12·90
1936	13·07

Average price in annas and pies obtained in the Calcutta market :—

	Export.	Internal.
1934-35	8-9	5-2
1935-36	9-5	4-10
1936-37	10-1	4-8

It is difficult to obtain wholly reliable figures of consumption in India, but the amount made available for this country seems to be going into consumption as may be gathered from the increasing amounts sold at the Calcutta auctions.

The following table shows the distribution of tea for internal consumption in the different provinces of India and also Burma for 1936-37 :—

	Lbs.
Bengal and Assam	12,254,844
Bihar and Orissa	1,966,689
United Provinces	2,513,819
Punjab, including Delhi, Sind and Baluchistan	8,142,467
Central Provinces and Berar	2,571,346
Bombay	28,004,785
Madras	13,838,485
Rajputana	413,650
Central India	895,434
Hyderabad (Deccan)	1,393,509
Mysore	1,435,575
Kashmir	847,460
Burma	14,816,366
Total	89,094,429*

* A revised estimate of the tea available for consumption in India and Burma places the figure at 96·0 million lbs. for the year 1936-37. The difference of 7 million lbs. may be accounted for as stocks in producing centres and tea in transit on 31st March, 1937 and so not accounted for as imports into the various provinces.

In order to further encourage tea drinking in India, the Indian Tea Market Expansion Board allots large sums of money for propaganda in India. In 1936-37 the sum so allotted amounted to fourteen lakhs of rupees. The climate of Northern India was of an unusual character. During the last three months of 1935, very little rain fell and in the early months of 1936, hail-storms occurred. Both these factors seem to have militated against the production of both crop and quality, in the early part of the year. The season as a whole was a disappointing one for quality. South India also experienced a relative drought during April and part of May of 1936, which did much to counteract the benefit of the earlier rains.

In spite, however, of unsatisfactory climatic conditions in the early part of the year, gardens were able to make their required crops from reduced areas, and a considerable acreage was not plucked throughout the whole season. Bushes were allowed to grow without being plucked and it seems that if this is done intelligently the tea bushes are benefited and rendered capable of yielding better in the future, whilst the quality of the tea is at the same time maintained. The system of plucking common in North-east India, of allowing only a short length of new growth at the beginning of the season and after that plucking so as to remove any further growth, is very severe on the bushes and if not applied with discrimination can lead to deterioration of the bushes and to the increase of damage by pests and diseases. Whereas the system of allowing during the growing season new leaves to remain on the bushes above the original plucking, a system that is common in South India, does result in an improved appearance of the bushes and an apparent reduction in the amount of disease in North-east India. It seems probable that the less severe plucking done in North-east India by reason of the tea-control measures has resulted in a diminution of the damage done by *Helopeltis theivora*, a pest that in former years has been responsible for great loss of crop.

In the last report, reference was made to the presence of the Shot Hole Borer (*Xyleborus fornicatus*) in South India. Further enquiry has revealed that on one garden in Travancore there has been a distinct increase of the pest, and that it is to be found on a number of other estates, but that it is not widespread, and that measures of direct control can be used. It is hoped that the industry of South India will be able to put into operation and maintain effective means for the control of this pest which has done so much damage in Ceylon.

The tea flower is generally cross-fertilised and consequently the progeny of any seed garden is mixed. It has already been proved that the cropping capacity of individual bushes varies; it has now been shown that the quality of the tea made from individual bushes having a common parentage also varies considerably. This brings into prominence the necessity for selection and propagation of individual bushes on which much work is being carried out at the present time in Ceylon, the Netherland East Indies, North-east India and Russia. The great importance of nitrogen as a manure to tea is well recognised. Recent experiments, however, have shown that the different manures have a different efficiency in respect to nitrogen they contain and that manures cannot be valued only on the total content of nitrogen, but the availability must also be taken into account, as for instance in North-east India, experiments have shown that the nitrogen in the average cattle manure has an efficiency of not more than fifty per cent of the efficiency of an equal quantity of nitrogen in the form of sulphate of ammonia.

10. Coffee

The coffee areas of India are distributed exclusively in the southern section of the Peninsula below 14° N., principally in the Mysore State, Coorg and the Madras province. The largest consolidated block of coffee, comprising about three-quarters of the coffee acreage, lies on the spurs of the Western Ghats and its sub-ranges (*e.g.*, the Bababudins) between 12° and 14° N., at altitudes ranging mainly between 3,000 and 3,200 feet above

sea-level. In the Nilgiris, coffee is grown on both the western and eastern escarpments at elevations ranging from 4,000 to 6,000 feet. Where the Eastern Ghats debouch on to the Nilgiris, a further area of coffee is found in the Biligirirangans. Proceeding in an easterly direction from the Nilgiris, an isolated block of coffee is found situated in the Shevaroys, a range running parallel to the Eastern Ghats. South of the Nilgiris, over the Palghat gap, the area under coffee diminishes, the main estates being confined to the Nelliampathies and the Anamallais. Coffee is grown only to a very minor extent in Travancore and Cochin.

The number of reporting estates in 1936-37 was 6,911 covering a total area of 337,687 acres as against 6,823 estates with an area of 335,115 acres reported in the preceding year. Of these estates, 3,169 small holdings, each comprising from 5-10 acres, contributed 21,144 acres to the total. The area actually carrying coffee was 56 per cent of the total, *i.e.*, 190,030 acres. The percentage distribution of the coffee acreage is as follows :—Mysore 55, Coorg 21, Madras 23, Orissa, Travancore and Cochin together 1.

The total production of coffee in 1936-37 originally estimated at 259,500 cwts., actually reached the satisfactory figure of 376,524 cwts. (42,170,657 lbs.), which is the highest production recorded over the last ten years (or more). The production, acreage and yield per acre of the main producing areas are as follows :—

—	Production in lbs.	Acreage	Yield per acre 1936-37	Yield per acre 1935-36
Madras	7,410,485	43,569	192	318
Coorg	11,081,240	39,163	302	278
Mysore	14,944,223	104,177	168	192
Travancore	137,963	1,076	181	251
Cochin	433,826	1,965	232	332

During the year under review, there was a slight decline in the amount of coffee exported, the figure being 211,000 cwts. as compared with 216,000 cwts. in the preceding year. Although this decrease of 2·4 per cent of the exported coffee is hardly of importance, its significance is increased when taken in combination with the decrease in the unit value of the exported coffee. Thus, the unit value, *i.e.*, the price realised per cwt. of coffee, in 1935-36 was Rs. 47, whereas in 1936-37 this value diminished to Rs. 40 (total value of exports Rs. 84 lakhs), a decrease of 17·5 per cent.

France maintained its position as the largest purchasing country of East Indian coffee, and the greatly increased demand shown in that country during the year 1935-36 (82,804 cwts.) was further augmented in 1936-37 by some 4,000 cwts. bringing total imports to France of Indian coffee up to 86,745 cwts. In general, continental centres maintained a good demand for Indian coffee, notable strengthening of the markets in Holland, Norway and Belgium being recorded. Exports to Germany and Italy showed a distinct decrease. A marked decline in the amount of coffee imported into the United Kingdom took place, only 34,993 cwts. being absorbed as compared with 73,071 cwts. in the previous year.

During the year 1936-37, the crop realised an appreciably improved price on the London market, as compared with the previous season, an average of 73*s.* being obtained throughout the February to June auctions. The price quotation for Superior East Indian quality coffees remained steady at 118*s.* per cwt. on a parity with the previous season's price for high grade coffee. Moreover, while in the previous season, a serious drop in price was experienced after some two months' auctions, the value dropping to 38*s.* 6*d.* per cwt., a recurrence of this situation did not occur during the 1936-37 sales. On the Mangalore market, the year's average price showed an increase of Rs. 6 per cwt. over that of the previous year. It will be observed from the following table that this increase was the first realised over a period of nearly ten years, during which a

steady decline had been proceeding without interruption since 1929-30. The following figures are for plantation coffee in the Mangalore market and may be viewed as the most accurate indication of the trend of prices for East Indian coffee on the Indian markets :—

Season	Lowest	Highest	Approximate average
	Per cwt.	Per cwt.	Per cwt.
	Rs. A.	Rs. A.	Rs. A.
1926-27	73 0	81 12	76 0
1927-28	77 8	82 0	78 0
1928-29	77 0	88 8	86 0
1929-30	60 0	88 12	87 0
1930-31	42 0	55 0	46 0
1931-32	51 0	63 0	60 0
1932-33	40 0	55 0	51 0
1933-34	40 0	52 0	46 0
1934-35	38 0	51 0	44 0
1935-36	25 0	36 0	31 0
1936-37	30 1	42 8	37 0

The Indian Coffee Cess Committee continued to fulfil its function of promoting the demand for East Indian coffee both in India and overseas. As a result of the short experience in the previous year, a number of changes in the working of the Committee and in the manner of executing propaganda work were considered desirable. Hitherto, work had been distributed between the Sub-committees, an executive, consisting of six members, responsible for finance, and a Market Expansion Section, consisting of five members, entrusted with plans for propaganda in India. It was decided to combine these two Sub-committees into one Executive Sub-committee of nine members who would deal with all subjects.

The institution of Indian Coffee Houses is probably the most important advance made by the Committee in its endeavours to

popularise coffee in India. Attempts made to encourage coffee consumption in Hyderabad had encountered a number of obstacles, due, in the main, to organisation difficulties. To remove these obstacles, it was decided to engage a firm with advertising experience to execute the plan of the Committee's propaganda campaign. This led to the establishment of Coffee Houses, the first being opened in Bombay. Other centres are now being considered. The main objective of these Houses has been the demonstration to proprietors of restaurants of the methods of making and serving good coffee. There has been sufficient success to warrant an expansion of this mode of propaganda.

The Committee has also been fully aware of the importance of maintaining overseas markets, this applying in particular to the United Kingdom. The necessity for propaganda in the United Kingdom may be seen from the figures already cited, which show the falling off in imports of South Indian coffee into Great Britain. To deal with this situation, the Indian Coffee Cess Committee has formed in Great Britain an ancillary Board, termed the Indian Coffee Market Expansion Board with the Indian Trade Commissioner as Chairman.

The special functions of this London Board are, firstly, to carry out propaganda to increase the consumption of Indian coffee; secondly, to make all relevant enquiries and to institute investigation; thirdly, to administer the funds earmarked for propaganda work overseas; and, fourthly, to co-operate with other Empire countries in joint propaganda while maintaining the identity of East Indian coffee. An important step in the fulfilment of these functions was the appointment of a Director of Coffee Propaganda, who, during the year under review, has carried out a vigorous campaign in Great Britain, visiting the main distributing centres and eliciting facts concerning the quality features in East Indian coffee demanded by the London trade.

The Indian Coffee Cess Committee has also been instrumental in inaugurating a marketing survey. An Assistant

Marketing Officer has been appointed and has been engaged in collecting information on the marketing of coffee in the different provinces and States. It is anticipated that the Report on this survey will appear during the coming year.

Scientific and agricultural investigations on coffee feature prominently in the programme of work of the Mysore Agricultural Department. While a considerable amount of laboratory work is carried out at Bangalore, the site of the field experiments is at Balehonnur, some 200 miles from Bangalore. The Experimental Station at Balehonnur consists of 290 acres of land, of which 120 acres are under coffee. The major portion, about eighty acres, of this coffee is approximately thirty years old, the remaining forty acres having been planted during the last nine or ten years. The revenue for the maintenance of this Station is derived from three sources, *viz.*, a cess of two annas per acre on all coffee estates of twenty-five acres and over, a Mysore Government grant equivalent to that raised by the acreage cess, and finally, the proceeds of the sales of the Station's produce.

An additional aid to coffee scientific investigations is provided by the United Planters' Association of Southern India in the form of a Coffee Scientific Officer. This Officer, with the permission of the Mysore Government, resides at the Balehonnur Experimental Station and co-operates in the coffee work of the Mysore Agricultural Department. An Assistant to this Officer has been investigating insect pests on the subsidiary Station at Sidapur in Coorg.

Investigations on the control of leaf disease (*Hemilea vastatrix*) were continued during the year, and the main conclusions so far reached have been embodied in a pamphlet. In this publication four important factors affecting control, *viz.*, climatic conditions, distribution of leaf-growth, seasonal development of the disease, and the most appropriate time for effective spraying, are discussed fully. The importance of early spraying as compared with spraying to protect the

maximum amount of leaf has been emphasised and consideration has been given to those conditions which should determine whether spraying should take place as soon as possible after the blossom showers or whether it could with advantage be delayed to afford protection to a greater area of leaf.

A miscellaneous set of other coffee experiments has been in progress. Manurial trials were conducted on the same lines as in previous years. Bhadravati tar emulsion was found useful in controlling coffee borer, which has become serious in Belur and Manjarabad taluks. Regarding selection work, among the fifteen mother-plants chosen, five have been giving uniform high yields, and of these S 48 ranked first both in respect of quantity and yield. The beans of S 44 have been assessed by coffee curers and buyers as being of superior quality. The first and second generations from the mother-plants are now under examination. Problems on the statistical and experimental sides of agricultural meteorology are being studied. Studies on the chemistry of coffee berry from blossom to bean were continued, and an investigation of cup quality of coffee received attention from the U. P. A. S. I. Coffee Biochemist, working under the direction of the Agricultural Chemist of the Mysore Agricultural Department.

An important aspect of coffee which has been receiving close attention is its quality. The subject was first introduced by the United Planters' Association of Southern India in 1933 (apart from the earlier work carried out some thirty years ago). The Association appointed a Coffee Biochemist in 1935, and after a period of nine months in its Tea Scientific Laboratories, he proceeded to Bangalore to work under the Mysore Agricultural Chemist. This year, owing to the depressed condition of the market and the importance of the quality subject, financial assistance has been requested from the Imperial Council of Agricultural Research.

11. Rubber

RUBBER is grown mainly in Southern India and Burma. The total reported area under rubber during the year was

228,168 acres, compared with 228,776 acres (revised) in 1935-36. Of this area 202,497 acres were tapped. Of the total area under cultivation, 45 per cent was in Burma, 43 per cent in Travancore, 6 per cent in Madras, 4 per cent in Cochin, and 2 per cent in Coorg and Mysore together. The total production of raw rubber during the year is reported to be 60,063,066 lbs. as against 48,545,045 lbs. in the previous year. The yield per acre of tapped area was 353 lbs. in Burma, 317 lbs. in Cochin, 253 lbs. in Madras, 252 lbs. in Travancore and 250 lbs. in Coorg. The exports of rubber by sea from India to foreign countries during 1936-37 amounted to 33·7 million lbs. as against 34·7 million lbs. in the preceding year. Of this, the United Kingdom absorbed 21·8 per cent, the Straits Settlements 28 per cent, Ceylon 13·7 per cent, Germany 10·1 per cent, the United States of America 15·2 per cent and Czechoslovakia 5 per cent. Under the Rubber Restriction Scheme, the exportable quota allotted for 1936 was 8,288 tons for India proper and 5,621 tons for Burma. The annual average price of standard ribbed smoked sheet in London in 1936 stood at $7\frac{3}{4}d.$ per lb., which is the highest since 1930.

No research work was carried out on rubber during the year.

12. Millets

Jowar (*Andropogon Sorghum*). The area under *jowar* in Hyderabad was 9,250,000 acres or 25 per cent of the total area in India, and the estimated yield was 1,571,000 tons.

Selection work on both *rabi* and *kharif jowars* was in progress and has already resulted in the evolution of two strains superior to the local.

Bombay Presidency (excluding the neighbouring States) carries an area of 9,096,000 acres under *jowar* with an estimated produce of 1,516,000 tons. In the South Central Division, four Maldandi strains, *viz.*, 35-1, M 9, 47-3 and 31-2, were tried against the local varieties. Trials with 35-1 on cultivators' fields in most of taluks of Sholapur district, part of Bijapur

and Poona, Nagar, Satara and Khandesh districts, established its superiority. Type 47-3 showed promise where *jowar* was irrigated. 12,200 lbs. of seed of these strains was distributed during the year.

In the Southern Division at the Dharwar Farm, selected strains of Fulgar White, Fulgar Yellow, Nandyal, Bilichigan and Savanur varieties of *jowar* were maintained pure and 6,164 lbs. of seed were distributed. Fulgar White gave the highest yield of grain (1,025 lbs), whereas Nandyal gave the highest yield (3,842 lbs.) of *kadbi* (dry stalks). Nandyal is a variety liked by the cultivators both for grain and fodder and is getting popular. If the results of all the previous years are taken into consideration, Nandyal stands first.

As a result of extensive propaganda, 436,000 acres were sown with *jowar* seed treated with sulphur dust against smut.

In the Bombay Presidency, the work of selecting Striga-resistant plants from different varieties was continued. Bilichigan P 3 is nearing purity for resistance. Muddinandyal has given a high percentage of resistant plants in its first year of selection.

MADRAS. The area under *jowar* was 5,121,000 acres with an estimated yield of 1,302,000 tons. At the Millet Breeding Station, Coimbatore, among the irrigated sorghums, there were two principal varieties Chitrai vellai (duration 110 days) and Chitrai manjal (duration 100 days). The existing strains, A S 1575, A S 2095 (Vellai *cholam*) and A S 809 (Chinna manjal *cholam*), continued to give the best results. In the main-season crop, comparative trials were conducted with Peria manjal, Talaivirichan and Tenkasi white *cholam* (=*jowar*). In Peria manjal series, A S 29 and A S 1098 and in Tenkasi variety, strain A S 550 gave the best results, but the latter was very early for the main-season crop.

As *jowar* is mostly grown for grain and straw, a number of varieties were selected for the study of their suitability for

fodder purposes. Juice was extracted and measured at three different stages of growth. The extraction at grain ripening time ranged from 11 to 20 per cent in pithy stalks, and from 30 to 46 per cent in juicy stalks. The sucrose content ranged from 2 to 13 per cent.

A number of varieties were tested for their suitability for pop corn-making. The variety Talaivirichan (*Sorghum Roxburghii* var. *hians*) produced the best results.

A start was made in producing strains resistant to Striga. Five single-plant selections isolated from African varieties were found to be completely resistant. All the local varieties were highly susceptible.

The inheritance of character " composite " short early and tall late in sorghum was pursued and set down to difference in internodal number and disposition in length. Studies on the waxy bloom on different portions of the plant, size and shape of anthers, pollen germination, linkage between the blackish purple colour of sheath and glume and the brown colour of the nuclear layer of grain were in progress.

In Coimbatore, five strains of *cholam*, of red, white and yellow colour and of dry *cholam* (Peria manjal), were introduced. A S 1575 (white) gave good results in Avanashi and Gobichettipalayam taluks. A S 29 is doing well in parts of both Salem and Coimbatore districts.

In Bellary and Kurnool divisions, there was a fall in the quantity of improved strains of *cholam* sold for seed. It is estimated that about 25,000 acres were sown with improved strains of *cholam* in the Madras presidency.

At the Dry Farming Research Station, Hagari, the root-studies showed that in sorghum type 1 (having compact ear-heads) the roots spread to a greater length laterally than in type 12 having loose panicles. The non-bearing plants (earless) were found to possess a very poor root-system, particularly defective in penetration into the soil. Germination studies revealed that the best results are obtained when the moisture content was 20-25 per cent. Above 25 per cent and below 15 per cent

sorghum grains failed to germinate. By development studies it was found that increase in the height of the plant precedes the increase in dry weight, the maximum growth-rate is obtained about the time of flowering and the maximum weight of dry matter is reached about 3-4 weeks after flowering.

At the Agricultural Station, Nandyal, soil requirements of different strains were investigated. Type No. 224 gave consistently good results and the difference as compared with the ryot's seed was 35 per cent and proved to be superior to all the old strains. It has been found that, under the conditions prevailing at the station, a large increase in the yield of *cholam* may be expected as a result of growing groundnut in rotation once in three years.

Investigations on the chemistry of malting *cholam* were continued during the year. The criterion adopted in the choice of varieties of *cholam* was low protein-content. Peria manjal *cholam*, grown under rain-fed conditions, was chosen for bulk trials and was found to be satisfactory. Keeping qualities of malt foods from *cholam* were still under investigation.

In the CENTRAL PROVINCES AND BERAR, the area under *jowar* was 4,658,000 acres and the estimated yield was 1,015,000 tons. The *jowar* crop suffered badly from unseasonable rains which seriously affected the germinating capacity of the seed. Seventy-seven different strains were raised in single-line cultures. Two recent types 123 A and E B 1 were becoming popular and the area under them was gradually extending. In the fresh material, No. 33, a white-skinned variety specially developed for Nimar, and 121 A proved suitable for extensive trials in the coming season. The use of copper carbonate and sulphur by the cultivators against covered smut of *jowar* was rapidly increasing.

PUNJAB. There were 928,000 acres under *jowar* with an estimated yield of 123,000 tons. J 8, which was evolved in 1932, has been tested extensively during the last four years and has proved to be a real dual-purpose type. 175 trials were

conducted with this type and out of these only 18 per cent were in favour of the local. Under favourable conditions, this variety grew to a height of eight feet and more and had a very high juice and sugar percentage. The results of regular feeding trials proved that it provided a maintenance ration after a fully matured crop of grain has been removed.

Twenty-two new selections, selected as a result of botanical analyses of Punjab types, were under preliminary trials. J S 20 and J S 21, the fodder types of *jowar*, were again found to be the best in trials conducted during the year and J S 21 established its superiority as regards fodder. Steps for the distribution of its seed were being taken.

At the Dry Farming Research Station, Rohtak, it has been observed that the application of manure to the *jowar* fodder crop made it more susceptible to the attack of stem borer. Trials with different seed-rates per acre of *jowar* showed that generally the lower seed-rates gave better results, but the results each year were greatly influenced by the moisture-content of the soil at the time of sowing. It was observed that minimum moisture-content necessary for germination was about 6 per cent.

SIND had 402,000 acres under *jowar*. The estimated outturn was 91,000 tons. The main varieties of grain *jowar* evolved by the Agricultural Department were Acho Kartuho No. 1 for Lower Sind, Sacro Kartuho No. 1, Depart No. 1 and Red Janspur No. 3 for Middle Sind, Bagdar No. 1 and Allakh No. 2 for Upper Sind. All these gave higher outturns than the local. Certain hybrids grown in the F_2 generation appeared promising. Acho Kartuho Turi, Red Turi and Achi Turi established their superiority as fodder *jowars* and their seed was being distributed.

The work on the evolution of dual-purpose types giving high yields of both grain and fodder was in progress.

In the NORTH-WEST FRONTIER PROVINCE, trials conducted with different types during the last three years showed that Sakrand and Australian *jowars* were superior.

In BIHAR, 73,000 acres were under *jowar* and the estimated outturn was 18,000 tons. Studies in *jowar* were very encouraging and a number of line cultures were breeding true.

In INDORE, the principle of basing selection on variance as well as mean values was exploited by the replicated progeny-row technique that has been evolved at the Institute. In *jowar* four successive stages of selections were compared in two families. The data on germination, lodging and grain yields were examined statistically. In the progeny-row test in *jowar*, No. 3 gave a 25 per cent increase in yield of grain over the local.

In TRAVANCORE State, experiments have been in progress at Puliyara Farm for some years. As in the previous years, Mankumari gave the highest yield and Palvella was second. Manuring experiments confirmed the previous years' results that synthetic farmyard manure gave the highest average yield which was 16 per cent more than that of plots to which equal quantities of cattle manure were applied. Among the chemical fertilizers, Parry's *cholam* fertilizer gave the highest yield.

BENGAL had only 6,000 acres under this crop. The " Rajshahi " type was multiplied for distribution to cultivators.

Bajra (*Pennisetum typhoideum*) is an important dual-purpose crop and the area under it is 15·3 million acres.

PUNJAB. The total area of *bajra* was 2,851,000 acres and the estimated outturn was 360,000 tons. *Bajra* type A 1/3 and G 61/21, evolved by the Department of Agriculture, continued to give better yields than the local types. A 1/3 was tested at 65 centres in all the *bajra*-growing tracts of the Province and its average yield in all the tests was 9 maunds 3 seers against 7 maunds 20 seers from the local *bajra*, giving an increase of 21 per cent. Studies to evolve early strains of A 1/3 are in progress.

Type G 61/21 was tested at thirty-nine centres in the Province and, on the average, yielded 17·4 per cent more than the local. This type possesses long hairs on its surface and thus birds are inclined to leave it alone if other food is available.

At the Dry Farming Research Station, Rohtak, trials with different seed-rates showed that generally the lower seed-rates gave better results, but these were greatly influenced each year by the moisture content of the soil at the time of sowing. Different strains of *bajra* were tried with a view to find out drought-resistant strains. Growth-rate studies showed that *bajra* A 1/3 produced more vegetative growth and formed ears much later than the local. Root studies revealed that A 1/3 had a larger root-system than the local with little difference in the depth reached. It was observed that *bajra* in the manured plots was able to obtain more moisture from deeper layers. The minimum moisture content necessary for the germination of *bajra* seed appeared to be about 6 per cent.

BOMBAY. The area under the crop was 2,311,000 acres. The scientific work on the crop was undertaken at Niphad. Intensive inbreeding was in progress to obtain pure types as an initial stage for further botanical work.

Different seed-rates of 1, 2, 3, 4 and 6 lbs. of African *bajri* and Niphad local were compared. The statistical analysis showed that there was no significant difference in the yield of grain, but in the case of fodder the results were in favour of the African type. The varieties showed significant differential response to different seed-rates. The African had significantly smaller size of grain and lower bushel weight than Niphad local. The African *bajri* was late by about eighteen days and was of extremely doubtful utility.

In Gujarat, types 206 and 207 were significantly superior to the local in yield.

MADRAS. The area under this crop was 2,768,000 acres with an estimated outturn of 709,000 tons. P T 2125 and P T 2548 were good in comparative trials as irrigated crops giving 19 per cent and 41 per cent increase respectively over their controls. Among the rain-fed varieties, P T 248 and P T 504 were found superior to others. The correlations between the total grain yield per plant and height of the main axis, the number of nodes on it and the total number of earheads

were determined in six rain-fed varieties of pearl millet in two years. It was observed that the number of heads was correlated with yield. Other factors were but slightly correlated. The yield of the main earhead can be predicted with a fair amount of certainty when the surface area of that earhead, the thickness of its peduncle and the height of its axis are known.

A study of the bristle character of *bajra* indicates that the longer the bristles, the greater the shedding and the less the density in the packing of the grain.

In the I circle, Punjab and Poona varieties gave an increase of 22·6 and 21·0 per cent respectively over the local varieties. In the VI circle, 205 acres were under improved strains. Punjab *bajra* was introduced in a number of villages and was popular. In the VII circle, Punjab *bajra* (P T 499) was demonstrated. In a general way the variety is liked on account of attractive ears. 805 lbs. of seed were distributed.

In the HYDERABAD State, the area under *bajra* was 2,162,000 acres with an estimated outturn of 127,000 tons. The Cawnpore awned variety was being introduced and became very popular in the eastern districts of the State. 1,069 acres were under it during the year.

SIND. There were 802,000 acres under *bajra* and the estimated outturn was 83,000 tons. Five types, Jamnagar Giant, Sujawal, A 1/3, G 63/28 and local were tested in four replications. Jamnagar Giant gave significantly better results, Sujawal and Punjab G 63/28 standing next in order of merit. Jamnagar Giant was tested at a number of centres on zamindari lands and in each of the centres it yielded considerably higher than the local.

COCHIN. The Navanagar variety was thriving well and could with advantage be cultivated for fodder.

NORTH-WEST FRONTIER PROVINCE. Australian Smooth gave better results than the local varieties. In thirteen demonstration plots on zamindari land, this variety beat the local at every place. The average increased yield was about 50 per cent.

INDORE. Twenty-five samples were grown in non-replicated blocks to study growth and tillering and some of the promising ones out of these were to be sent to Nimar and Rajputana for trial. Jamnagar *bajra* and A 1/3 were compared against local at Alwar, Khetri, Jaipur and Jodhpur. At Alwar, Jamnagar Giant gave significantly higher yield than the other two both in grain and straw. Because of lateness, want of hardiness and inconsistent behaviour from year to year, Jamnagar was not to be widely advocated. A 1/3 was found to be as good or slightly better than the local. Both Jamnagar and A 1/3 were found to be resistant to smut.

BIHAR and ORISSA. *Bajra* occupies an area of 72,000 acres and the estimated outturn was 27,000 tons. A systematic botanical description of *bajra* type Sabour 1 was carried out.

Ragi (*Eleusine coracana*). It is of importance in Peninsular India only, although it is grown in small quantities all over India.

MADRAS. At the Millet Breeding Station, Coimbatore, E C 3517 and E C 3030, with duration of 112 and 117 days respectively, were the best among the summer season varieties. In the main season crop E C 2985 gave a 10 per cent increase over E C 593. E C 593 is very popular and is fairly extensively grown in the Province. The main defect of the type is that it takes a fortnight more than the local to ripen. In the Presidency, 10,577 lbs. of improved seed were distributed during the year.

Testing of nutritive value by the Government Chemist showed that, while white *ragi* had a higher nutritive value, in the brown *ragi* protein had a higher biological value. A dominant gene Vt was found in African varieties which coloured the ordinary purple in *ragi* and made it appear violet.

Investigations were also made on *ragi* regarding their suitability for malting purposes. A distinct advantage in this case was its low nitrogen and fat contents.

MYSORE STATE. The yields of several varieties of *ragi* were tested. Among Kar varieties, H K 82 was found to be the best yielder in the Botanical plot and H K 13 in the bulk plot.

In the BOMBAY PRESIDENCY, improved strains, A 16, B 11, E 31, E 82, E 44 and E 62 were being multiplied at Hatkhamba Station. The purity of seed was maintained by roguing and bagging of enough earheads of each strain. The total quantity of seed distributed to the registered seed-growers during the 1937 season amounted to 1,758 lbs. in the South Central Division, Poona.

In COCHIN, ragi was under trial on the west coast in garden compounds and elsewhere, and was thriving well.

Other millets. Among other millets, the Italian millet (*Setaria italica*) is the most important. At the Millet Breeding Station, Coimbatore, eleven economic selections were under trial. Out of these, S 1523 was outstandingly good, giving 25 to 35 per cent more yield.

It was seen that tall plants with an average height of about 110 cm. are simple dominant to short plants with an average height of 75 cm., the segregation being monogenic. The plant with longer internodes had greater heads and grain weights.

At the Hagari Dry Farming Research Station, germination studies showed that below 15 per cent moisture in the soil there was no germination and the best results were obtained when the moisture content was 20 to 25 per cent. Above 25 per cent there was a decrease. K 23 (a many-tillered variety) had a better root-system both in lateral spread and penetration into the soil than K 191 (a few-tillered variety). Development studies showed the same general indications as in *jowar*. Some of the other lesser millets were also under trial at the Millet Breeding Station, Coimbatore.

Panivaragu (*Panicum miliaceum*)—From the economic point of view, two early and good yielding types, P V 31 (dark olive grey coloured grain) and P V 36 (buff yellow coloured grain) were isolated and multiplied for distribution. Inheritance of different characters was being studied.

Samai (*Panicum miliare* Lam.) was under study at the Millet Breeding Station, Coimbatore.

13. Other Cereals

Barley. Acreage returns of this crop were not quite complete, but from the major figures available it appears that an area little short of 6·5 million acres was under barley in India in 1936-37, of which the United Provinces, Bihar and the Punjab, combined, with their 4·06, 1·27 and 0·74 millions, respectively, contributed about 94 per cent.

Analytical results from barley samples of 1935, sent to the Institute of Brewing, London, by the United Provinces, Bihar and Orissa and the Punjab in pursuance of the scheme of the Imperial Council of Agricultural Research for investigations into the malting and brewing qualities of Indian barleys, were received during the year under report. All the twenty-four samples from the United Provinces were of barley Cawnpore type 251, grown at three different centres, with eight manurial treatments at each, *viz.*, unmanured (control), 1 cwt. ammonium sulphate, 1½ cwt. potassium sulphate, 3 cwt. superphosphate, 1 cwt. ammonium sulphate + 1½ cwt. potassium sulphate, 1 cwt. ammonium sulphate + 3 cwt. superphosphate, 3 cwt. superphosphate + 1½ cwt. potassium sulphate and 1 cwt. ammonium sulphate + 3 cwt. superphosphate + 1 cwt. potassium sulphate, per acre. From the results obtained, it appears that these different manurial treatments caused no difference in malting quality. For example, 1,000-kernel weight, malt extract per 448-lb. of barley having 10 per cent moisture, Brewer's extract (in pounds) calculated on dry malt, soluble nitrogen, total nitrogen, etc., figures from all the treatments were more or less the same. But there was great variation in the quality of the same barley, when grown at different centres. For example, the Valuation Sub-Committee remarked that of the samples of the same barley (Cawnpore type 251), the one grown at Kura Ghat Farm was a very useful, excellent malt-making barley, with irreproachable analyses and low malting loss; while that grown at Raya Farm

did not evidence any improvement on ordinary Indian commercial types, being fit for use by distillers only, but not good enough to find a ready market and of little or no interest to brewers. Barley samples of the same type from Kalai Farm, however, were adjudged to be midway between Kura Ghat and Raya samples. All this definitely shows, as was also mentioned during last year in connection with the barleys of Bihar and Orissa, that climatic and edaphic factors play a very important part in determining quality in this crop.

On the whole, however, the Valuation Sub-Committee was of the opinion that barley Cawnpore type 251 had proved to have a satisfactory malting quality.

In the case of Bihar and Orissa samples, forty in number, consisting of a set of twelve, in duplicate, sent by the Department of Agriculture of Bihar and Orissa and of a second set of eight, also in duplicate, sent by the Director of the Imperial Agricultural Research Institute, only those grown at Patna and those only of local barleys were considered good in quality, Pusa 21 grown at the same place being adjudged as of not so good a quality. The other barleys from this Province, including Pusa 1, Pusa 2, Pusa 12, Pusa 20, Pusa 21, Pusa 22, Pusa 23 and Pusa R 1, were of poor or only medium quality. The Valuation Sub-Committee matched these with other types of six-rowed barley, closely corresponding to them, and concluded that the best two of them, *viz.*, Pusa 21 from Sabour and Patna Local, were in appearance similar to Chilian. Some, *i.e.*, Sabours J, L, M, O, R & U, were similar to Tunisian, Ben Ghazi or Algerian, but the rest were so dark brown in colour as seriously to prejudice their selection by brewers. Analysis figures from them were similar to those of 1934, but were rather lower for the extract factor and permanently soluble nitrogen. The average extract was about 93 lbs., corresponding with 103 lbs. per 448 lbs. of raw barley. The extract factor constant A was 104, while the permanently soluble nitrogen averaged 30·7 per cent of the total, corresponding with that given by most Californian malts.

In the case of the Punjab, the report gave malting and brewing results of two Punjab barleys, *viz.*, types 4 and 5, grown at five different places in the Province. These five places were as follows :—

(1) Ferozepur, a district in the plains, with low rainfall, where the two types were grown both under *barani* and well-irrigated conditions.

(2) Gurgaon, a district in the south-east, whose barleys are much sought after by breweries all over India. Here barleys are grown with well-irrigation. But this year's barley from this district was rather shrivelled, due to yellow rust attack.

(3) Kangra, a hilly district in the north of the Province with plenty of rainfall.

(4) Lyallpur, a typical canal-irrigated colony district.

(5) Multan, a district with very scanty rainfall, where barley is grown with the help of irrigation.

The results show that with regard to nitrogen-content the lowest figures were got from the Kangra samples, and the next lowest from Ferozepur ones. Taking all the samples together, both the types gave low to medium figures of nitrogen (with an average of 1·58 per cent), excepting type 5 from Lyallpur and Multan. With regard to extract per 448 lbs. yielded by barley containing 10 per cent. moisture, the Kangra produce stood as high as 111·5 lbs. In other cases, too, the figure is quite high from both the types, excepting from type 5 grown at Multan and Gurgaon. With regard to the index of protein modification figures, both the types from Ferozepur, Kangra and Lyallpur gave figures rather higher than those normally given by Californian 6-rowed barleys. The average extract on dry malt was 97 lbs., and the extract factor constant A was nearly 107, which is very high indeed for a 6-rowed barely of this type. Comparing the Punjab samples with those from the other provinces, the following conclusions stand out clearly :—

(*a*) Of all the Indian samples tested, those from Kangra contained the lowest percentages of nitrogen

figures for which were 1·21 and 1·25 per cent as against 1·39 per cent, the lowest figure yielded both by the Bihar and Orissa and the United Provinces samples.

(*b*) With regard to malt extract figures also, Punjab barleys ranked higher than other Indian barleys. Further, Punjab barleys lost less dry matter during malting than barleys from other provinces.

On the whole, the Valuation Committee were impressed by the potential value of the barleys of the 1935 crop examined, as malting matter both for brewers and distillers in the United Kingdom. There are already several important breweries who realise the value of Indian barleys, when these are offered in some of the qualities examined this year, and it is perhaps only a question of time before these better types become more generally popular, if they can be offered in commercial quantities.

Yield Trials. In yield trials at Sabour and Jamin Farms in Bihar and Orissa, Pusa types 21, 22, 23 and 23-10, being tried for the last four to six years, have not yielded better than the locals. Similarly, it is not expected that Pusa 21, the standard barley in Tirhut at present, will ever be popular there with the growers, as, though an excellent cropper, it is very much liable to smut.

In the PUNJAB, fourteen cross-bred types were, for the first time, under trial, in replication, against the standard types 4 and 5 at Lyallpur, and against type 4 at Gurgaon. In these trials, cross 103 gave the highest yield at Lyallpur and outyielded both types 4 and 5. The ear-shape of this cross is just like that of type 5, but it is earlier in maturity than type 5. At Gurgaon none outyielded or equalled type 4, but C 105, C 103 and C 112 came near to it. Determinations of 1,000-kernel weights of these crosses show that some of them stand in this respect very high. For example, C 108 gave a figure of 47·1 grms., as compared with 41·06 grms. of type 4.

According to the results already arrived at, the most suitable barley for late-sown, irrigated conditions in the Punjab is barley type 4. This year two other barleys, *viz.*, 1-0624 and Thangzad, which are very early in earing, and six early ripening wheat varieties were under test against barley type 4 under such conditions. The first sowings were made on the 18th of December, which were repeated at intervals of about a week until the 28th January when the last sowing was made. In these sowings, two wheat varieties, *viz.*, C 591 and 9-D, and barley type 1-0624 (2-rowed, husked) gave the best outturns. Owing to the extreme earliness of Thangzad, which comes from Lahaul, a hilly tract in the Kangra district having an altitude of 11,000 feet, and which begins earing only about forty days after sowing, it had been thought that it would do extremely well in such sowings, but these hopes were entirely falsified, as it gave a hopelessly poor yield in these trials. From this it is evident that earliness alone is not the deciding factor for the suitability of a variety for late sowings.

In the NORTH-WEST FRONTIER PROVINCE, English malting barleys have done well but, being 2-rowed, their yields are low. On the other hand, an English 6-rowed winter barley has proved a slightly better yielder than the local and its malting qualities are fair.

Other Studies. An examination at Pusa of the internal stem structure of the F_2 plant of a cross between a lodging and a non-lodging barley showed that the development of the mechanical tissue is controlled by Mendelian factors, two factors being concerned. In the non-lodging type, the sclerenchymatous tissue was thick and well developed, and regular sub-epidermal " girders " were present, which help to strengthen the culm. In the lodging type, on the other hand, the sclerenchyma was poorly developed and hardly any sub-epidermal " girders " were present. Root-studies showed that shallow-rooted barleys were characteristically earlier in maturity than deep-rooted ones.

383 barley samples sent by the various Marketing Officers from the provinces to the Imperial Agricultural Research Institute, New Delhi, were physically examined and malting tests on a selected number of these samples were also subsequently conducted at the Dyer Meakin Brewery, Solon. At the close of the year, chemical analysis of these samples was in progress.

Maize. The area under maize in British India was over six million acres, with the United Provinces, Bihar and the Punjab with their respective figures of 1·96, 1·64 and 1·7 million acres contributing about 76 per cent of this total.

At PUSA, breeding and genetic investigations were continued. Eight American varieties on being self-fertilized showed segregation in respect of seed-colour, seedling and mature plant characters, etc., and a large number of mutant types, which remained concealed under conditions of commercial crop production, were revealed.

In BIHAR, selection work was proceeding on the same lines as in the 1933-34 season. At the Banka Farm, local varieties were tested against Tinpakhia and Jaunpore and the same against Italian, Tinpakhia and Jaunpore at Jamin Farm. The results showed that the locals were as good as the others, excepting at Jamin Farm where Tinpakhia and Italian gave somewhat higher yields.

In the PUNJAB, the technique evolved to check cross-pollination in breeding plots continued to work satisfactorily. Usually, under ordinary conditions, cross-pollination is about 90 per cent but the method of surrounding the maize-breeding plots by 15-feet wide borders of *arhar* and sugarcane reduced the cross-pollination to 0·8 per cent and 5 per cent respectively. Elephant grass also has proved for this purpose equally effective, though less remunerative. The acclimatisation work on about twenty-three foreign types was for the second year continued. Type Red 1 was tried extensively at Sirsa, Karnal, Rawalpindi, Gurdaspur and Lyallpur and in practically all cases it yielded considerably more than the local types.

During the year 342 market samples of maize, received from all over India, were examined and reported upon by the Cerealist, Punjab Agricultural College, Lyallpur, in connection with grade standards work of the marketing scheme of the Imperial Council of Agricultural Research.

In the NORTH-WEST FRONTIER PROVINCE, about four lakh acres, representing 15 per cent. of its total cropped area, is sown under this crop. As local varieties are susceptible to borer attack, to escape which they have to be sown late, *i.e.*, in July, and as in the Peshawar and Mardan districts maize is usually followed by wheat which should be sown before the tenth of November, the only popular varieties are those which mature rapidly, *i.e.*, in about ninety days. As the maize-wheat rotation is thoroughly bad from many points of view, the Agricultural Department of the Province recommends that maize should be rotated with berseem, the latter to be sown in the standing crop of the former in September and to be harvested in June, thus allowing plenty of time for sowing maize again in July. With this rotation, a slower maturing and therefore higher yielding American type of maize, which as a class is more resistant to borer attack, can be grown. With this object in view, an American variety, " Pride of Saline ", got from Egypt, has been tried for the last two years and has consistently yielded better than the locals by about 20 per cent. It has to be seen, however, to what extent the practice of unrestricted stubble grazing in early-maize fields to which zamindars are accustomed and which would interfere with the recommended practice, would militate against the new variety becoming popular.

Oats. At PUSA, certain qualitative and quantitative characters were studied in the F_2 and F_3 generations of some crosses. The study of sterility in exotic oats was continued. The study of resistance of oats to covered smut is also in progress, and some single-plant selections resistant to covered smut have been made. In the PUNJAB, among early-maturing oats, Pusa hybrid " J " gave the heaviest outturn of fodder, while

amongst late and coarse varieties, French and Golden Rain gave the best yields on rich soil with an ample water supply. The finer types, Algerian and Fodder Specialist's selection 1/29, are not exacting in their soil and moisture requirements and hence have been found to be more useful under conditions where irrigation is restricted. They are the only two types which have given very good results under *barani* conditions.

14. Potatoes

THE work on potato-breeding both at Simla and at Nanjanad was continued. At the former centre, 294 stocks received from various parts of India were under study with the object of determining the most suitable varieties for crossing with new species and varieties received from abroad. Fresh material including the species *Solanum phureja* was obtained from Cambridge, Leningrad and America. Although no controlled tests of resistance to Late Blight could be undertaken, the field resistance of the different species and hybrids to a natural epidemic of this disease was studied. The results showed varying degrees of resistance to Late Blight by varieties of wild and cultivated potatoes. In general, the varieties of *S. tuberosum* were highly susceptible. Slight resistance was shown by Pusa White, Gharwal, Khabrar, Coonoor White and Darjeeling Red and moderate resistance by President. Most of the varieties of *S. andigenum* were highly stem-resistant. The foliage in the earlier stages of growth also exhibited a high degree of resistance but later it was attacked and there was a moderate degree of infection. The species *S. demissum*, *S. Antipoviczii* and *S. neoantipoviczii* were immune to the disease, whilst *S. Fendleri*, *S. Maglia*, *S. otites* and *S. leptostigma* were highly susceptible. The three hybrids [*S. demissum* × *S. tuberosum*, *S. Antipoviczii* × *S. tuberosum* and (*S. Antipoviczii* × *S. tuberosum*) × *S. tuberosum*] exhibited a very high degree of resistance, but unfortunately their yielding capacity was not very satisfactory, and further the stolons were very long and the tubers small.

A large number of crosses was made between the best Indian varieties and the most promising foreign ones. It was noted at Simla that crosses in which *S. demissum* was the female parent and *S. tuberosum* the male parent were much more successful than the reciprocal crosses.

Cold storage trials of seed potatoes were carried out at the Cold Storage Research Station at Kirkee. The results indicated that potatoes may be stored at temperatures of 35° and 40° F. for about a year with almost no loss. In the case of some varieties, however, the germination of the tubers stored at the lower temperature appeared to be somewhat impaired.

MADRAS. The area under this crop during the year was 21½ acres at the Nanjanad Agricultural Station and as usual three crops were raised. The irrigated, the main and the second crops yielded 600, 575 and 500 maunds respectively per acre. The work on artificial pollination was continued on all three crops and 627 seedlings were raised. Out of the two Russian types, only one, namely No. 8178, produced one tuber. Two hundred and seventy-seven hybrid varieties were grown under irrigated conditions. Some of them indicated better yield and earlier maturity than the local. Fourteen varieties were under row-yield trials and eleven under comparative trials.

In the permanent manurial plots, the phosphatic series showed good results and the beneficial effects of lime were noticeable. The earliest potatoes to mature were in the phosphatic series. The addition of nitrogen to phosphatic manures tended to slightly delay maturity. Irrigation once or twice a week or on alternate days produced no difference in yield. In experiments to judge the value of different weights of individual tubers sown at different spaces, tubers weighing two ozs. and sown at six or nine inches distances gave the most economical returns.

PUNJAB. A large number of foreign and indigenous varieties was tested for yield both in the hills and in the plains. The variety Factor has given a very creditable yield in the Murree Hills where it is estimated now to occupy 90 per cent.

of the area under potatoes. Recent work on the potato crop has been developed mainly with a view to ascertain whether the Kangra Valley can be used as a centre for potato-seed supply for the plains and so make unnecessary the importation of potatoes for seed from localities outside the province, thereby cheapening the cost of production of this crop.

ASSAM. On the Upper Shillong Farm, fifteen varieties were grown on a field-scale for trial and seed production. The average yield per acre was 87·7 maunds which is about the same as that obtained in the previous year. In manurial trials, the best results have been obtained consistently by an application of 200 lbs. Nicifos + 200 lbs. sulphate of ammonia. Increases were obtained with cattle manure up to 400 maunds per acre. Some work on the selection of disease-free types was also continued. In the Upper Assam Valley, growing two crops of potatoes in the same season was attempted with encouraging results. The second crop was planted about the middle of February and harvested towards the end of April. It afforded greater facilities for the preservation of seed for the next growing season.

SIND. During the year under report, tubers of three varieties, Patna, Kutwa and Italian, were kept in cold storage and planted. Germination was irregular and the crop subsequently succumbed to blight.

NORTH-WEST FRONTIER PROVINCE. Varietal trials at Parachinar showed British Queen, Great Scot, Arran Chief and Eclipse to be the best varieties. Yields of over 200 maunds per acre were obtained, but the seed deteriorated rapidly. An experiment in underground storage using lime and sand reduced the loss by 25 per cent. Search is being made for a hard-skinned early variety as this is considered to be the best for seed purposes.

KASHMIR. During the year under report, twenty-one varieties, of which twenty were acclimatised foreign and one local, were under trial. Scotch No. 1 produced the highest yield of 161 maunds per acre. All the varieties were white-skinned and

generally did not appeal to zamindars who prefer red-skinned types, because they are considered to keep well in storage and to bear transit better than white-skinned varieties.

15. Beans and Pulses

Gram (*Cicer arietinum*). This is the most important pulse cultivated in India. The estimated yield was 4,204,000 tons from 17,956,000 acres. It is grown practically all over India.

PUNJAB. Gram occupies 4,908,000 acres with an estimated outturn of 953,000 tons. For many years past the gram crop in the North Punjab, particularly in parts of Attock district, has suffered from a fungal disease known as gram-blight. In years climatically favourable to the spread of this disease, the crop which has been attacked is entirely destroyed and even in years less favourable to the disease, considerable loss has occurred.

Research carried out by the Punjab Agricultural Department showed that this fungal disease is borne in the seed, but the most serious source of infection lies in diseased material from previously attacked crops. It was found that when such debris is left lying on the surface of the ground, either on old threshing floors or in fields which have been attacked by the disease, it is capable of transmitting the infection for three years, after which it is no longer viable. If, however, the diseased material is buried in the ground by means of a furrow-turning plough, it becomes harmless after a few months. Consequently, it is possible not only to control but entirely eliminate gram-blight by—

(*a*) thoroughly cleaning up and burning all trash remaining on threshing floors and by burying diseased debris in old gram fields with the aid of a furrow-turning plough;

(*b*) by sowing seed free from the disease and imported from a locality where the disease does not exist.

Intensive clean-up measures of this nature were carried out for four years in Attock district and were successful in securing for the cultivator a good outturn from his gram crop in three of these years. The fourth year, however, proved unprecedently favourable climatically for the spread of this disease. Fresh infection was carried into the cleaned-up area from surrounding localities which had not been cleaned-up and the disease spread to parts of the Province where hitherto it had been unknown.

In view of the difficulty of ensuring adequate clean-up measures for the complete control of this disease, the Agricultural Department undertook an investigation of the possibilities of overcoming the disease by botanical means. It was found that all the many varieties of Punjab gram were highly susceptible to this disease. A large collection of about 180 varieties of gram was, therefore, made from outside sources. Small samples of various grams, grown not only in other parts of India but in other countries in the world, were obtained. All these small samples were grown at Campbellpur, which is located in the centre of the worst affected area. Of all the varieties tried, only three showed resistance to the disease. All the three varieties were of French origin, but were obtained from the United States Department of Agriculture.

During the past five years these three varieties have been under continual experiment and selection and, as a result, a variety known at present as F 8 has been produced, which is practically immune to gram-blight. At the Department's farm at Campbellpur, during the past year, on an area of $2\frac{1}{2}$ acres this variety produced an average of 15 maunds of gram per acre in a tract where all other local varieties were completely wiped out. At Lyallpur, the same variety gave a yield of $18\frac{3}{4}$ maunds per acre. The Department now possesses 60 maunds of this selected gram, which will be multiplied under the most favourable conditions as rapidly as possible and it is expected that in 1940 the Department will be in a position to

distribute not less than 25,000 maunds of this new blight-resistant seed.

The discovery of a type of gram which is unaffected by this severe disease is an achievement of the utmost importance to cultivators in the gram-growing areas in the province. There is every indication that in future they need have no more fear of the ravages of gram-blight, which has involved them in losses of lakhs of rupees in the past. It is expected that as soon as seed is available, this new type will completely replace all local types grown at present. In colour, the seeds of F 8 are dusky yellow and in size they are larger and heavier than the usual Punjab types. Consequently, experience has shown that a seed-rate of twenty-four seers per acre has to be used against sixteen seers commonly used for the Punjab types.

Extensive trials with Pb 1 (Kabuli gram) were made all over the province. They proved that even at the greatly increased seed-rates of 40 seers and 50 seers per acre, this type could not compare in yield with Pb 7, but the much higher seed-rate per acre not only neutralized the financial effect of its low yield but turned the scales definitely in its favour. An endeavour was being made to combine by crossing the size and colour of grain of Pb 1 with the high yielding capacity of Pb 7.

Trials made all over the province established definitely that Pb types of gram Nos. 7 and 17 were better than others, but of the two neither could be said to be better than the other, as local conditions sometimes favoured one and at other times the other.

At the Dry Farming Research Station, Rohtak, 30, 40 and 50 lbs. seed-rates of ordinary gram were tried. The results were in favour of 50 lbs. per acre, while in 1935-36 these were in favour of 40 lbs. per acre. The results of the comparative trials showed that Pusa 58 was so far the best among the lot and that Pb 7 was unsuitable for the hard clay soils of this station, especially during years of poor rainfall.

Gram-wilt studies showed that wilting of the crop did not occur due to deficiency in moisture but was due to the presence

of an impervious sub-soil stratum. Root-studies were made and in case of Pb 7, roots were traced up to a depth of 46 inches and they had a spread of 18 inches.

BIHAR occupied 1,374,000 acres with an estimated outturn of 450,000 tons. Sabour types numbering eleven as well as Saharanpur and Netarhat cultures raised from single-plant seeds were again carefully studied and were found to be breeding true. The Sabour grams were characterised by similarity of characters with respect to white stamen filaments, reddish orange anthers, paler green and straight style with hairs, paler green stigma and pale green ovary which was slightly bent and hairy. All these varieties were botanically studied and described.

Several other promising cultures obtained from different localities in the province were under trial for selection work.

HYDERABAD had 1,253,000 acres under this crop and the estimated outturn was 200,000 tons.

In the CENTRAL PROVINCES and BERAR, there were 1,154,000 acres and the estimated outturn was 209,000 tons. Types 62 and 352 continued to give satisfactory results at Jubbulpore and Hoshangabad Farm, but type 62 did particularly well at the Raipur Farm and yielded 1½ times more than the local. For the wilt-infected areas in the north of the province, No. 352 was found to be the most suitable and its seed was being multiplied on the northern circle farms for distribution in wilt-infected areas.

Out of the twenty fixed crosses between No. 28 and Cawnpore (wilt-resistant), the promising strains were tested in randomized blocks at Nagpur. Of these, Nos. 33, 36 and 37 gave significant results. A number of other crosses were under study.

BOMBAY had 641,000 acres and the estimated outturn was 87,000 tons. At Dharwar, efforts were being continued to obtain wilt-resistant strains of gram. No. 18 showed only 1 per cent. wilted plants as compared with 74·4 per cent. in the local gram. At Niphad, certain early maturing strains of gram were the

most promising and gave much higher outturn than the local varieties.

The four early strains, G 258, G 397, G 693, G 746, and two late selections, G 130 and G 158, were under trial. Early selections were high yielders and during the year G 397 and the local gave significantly higher yields than the general mean.

In SIND, 347,000 acres were under gram. The estimated outturn was 50,000 tons.

In BURMA, 219,000 acres were under gram and about 8,000 acres were grown under Karachi gram. During the year Karachi gram from eight localities in Minbu district was reported to suffer from wilt disease. *Rhizoctonia* was isolated from all the specimens received. The infection was not severe.

In the NORTH-WEST FRONTIER PROVINCE, type 17 proved to be the best. The yield was 44 per cent more than the local and it was being distributed to cultivators.

MADRAS. 83,000 acres were sown with gram. Breeding work on mode of inheritance of seed-coat characters was under investigation. At Koilpatti, two strains, Nos. 468 and 482, from Cotton Specialist were promising and these were found to be resistant to wilt disease. Pusa types only flowered but did not set pods. At the Hagari Dry Farming Research Station, sixty-five selections were under replicated row trials. Twenty-nine selections have been made out of these for further trial.

BENGAL had 242,000 acres under gram. Comparative varietal trials with Pusa 6, Pusa 28, Pusa 58 and Sabour 4 and local at Krishnagar, Berhampore and Rajshahi showed that Pusa 58 was the best of all the varieties and appeared promising.

INDORE. C P 28, Sabour 4, P 67, P 18, Shirolli and Malida were tried at Jhalua, Dhar, Datia and Khetri. C P 28 proved suitable at Jhalua and Dhar, while Malida for Datia. C P 28 and Shirolli obtained the maximum premium over the local variety.

Pigeon Pea (*Cajanus indicus*). In SIND, Pusa types failed to grow, being late. Selection work in White Digri and Red Hyderabad Sind were in progress.

In the CENTRAL PROVINCES, seed No. 3, which is an all round good strain, was grown on nearly all the farms and was distributed to cultivators and to some farmers in the United Provinces and the Central Provinces. In Berar 3,800 lbs. seed of wilt-resistant strain No. 38 were distributed in wilt-infected area.

In BURMA, work on the evolution of a strain resistant to the beetle *Bruchus chinensis* was continued at Mandalay and Mahlaing Farms. In the East Central circle, the standard strains grown are Shwedinge and C 10.

In the Northern circle at Mandalay, a number of strains were under study by both the Economic Botanist and the Entomologist. In the Southern circle, Rangoon, New Era was increasing in popularity and the area under it was 400 acres. In the West Central circle, three Pusa varieties, T 15, T 10 and T 51, were tested at Magwe as well as at Allanmyo and were found to be late in ripening.

BIHAR. Six types raised from single-plant cultures were again carefully studied and fully detailed systematic description was completed.

Twenty-seven cultures were under comparative trial at the Cotton Breeding Station, Coimbatore. Selections from Gujarat, Dharwar and local types showed promise, some of them being very early. Inheritance of seed-coat colour was studied.

In BENGAL, four types (selections from Comilla *arhar*) were being multiplied at the Dacca Farm. Bankura *arhars* were found to be free from wilt and were early but poor yielders.

In ASSAM, at Jorhat Station, three Pusa varieties, namely, P 15, P 51 and P 64 and three selected varieties from Sylhet, namely Sylhet White, Sylhet Brown and Sylhet Deep Brown, were under trial. Pusa varieties P 15 and P 64 did very well.

About two maunds of seed was given for demonstration purposes.

At INDORE, two strains and three mass selected bulks were compared against local during the year. The two Pusa types tried during the year proved unsuitable for the Malwa tract. This was also under trial in COCHIN.

Cowpea (*Vigna catjang*). In SIND both red and white-seeded types were tested at Sakrand and one of the red types, *viz.*, Sakrand local, was found to be high yielding in seed production.

Three types of cowpeas (Sabour types) were systematically studied in BIHAR. The work on Putida cowpea was continued and was transferred to the Putida Farm.

At the Millet Breeding Station, Coimbatore, 550 single-plant selections were grown, and 160 types were marked out.

In COCHIN, cowpea was under trial in the interspaces of orchards, pine-apple gardens, etc.

Peas (*Pisum sativum*). In SIND, this proved to be a valuable fodder and a good rotation crop when grown for seed, yielding ten maunds per acre.

In the NORTH-WEST FRONTIER PROVINCE, varietal trials showed that the dwarf variety, requiring no support, was probably the most profitable. Yields of 1,200 lbs. of dried peas and 9,000 lbs. of green pods are possible.

In BURMA, ten varieties from Australia were under trial but these did not do well.

In BIHAR, fifteen types of peas were isolated and systematically described.

Lablab (*Dolichos lablab*). Four selections were under trial at the Millet Breeding Station, Coimbatore, of which D L 89 and D L 231 were found to be the best.

Lentils (*Lens esculenta*). In BENGAL, results of experiments conducted last year proved the superiority of Departmental selections 5, 7 and 12 over Pusa III-86, though the results were not very significant. Departmental selections 3, 5,

7 and 12 were tried with Barisal Massuri at the Rajshahi Farm. Barisal Massuri gave the highest outturn and was very near to type 5. This type was being studied with the object of evolving a pure strain. Seed-rate trial of 9, 12, 15, 18 seers per acre with type 5 showed that seed-rate of 9 seers per acre was significantly better. Type 5 was selected for multiplication and distribution.

Urid* and *Mung (*Phaseolus mungo* L. var. *Roxburghii* and *Phaseolus radiatus* L.). In SIND, these crops were largely grown in Karachi district. Selection work was in progress.

In the CENTRAL PROVINCES, investigations on these crops were continued and forty-six *mung* and twenty-six *urid* types were classified.

Types 18, 23, 37 and 38 in *mung* are new types which have not been recorded elsewhere. One of the chief characters in this is the peculiar colour of seed-coat which is deep black and glassy instead of green or pale. Comparative trials at Nagpur Farm showed that, in *mung*, types 160, 178 and 179 and in *urid*, Nos. 110, 112A and 126 produced very significant results.

In BIHAR, ten Sabour types and two from Sepaya and Newada of *kalai* (*urid*), which are breeding true, were botanically described. All the types were characterised by uniformity of vegetative and floral characters. The flowers throughout are greenish yellow. The characters of pod and seed alone were found to be of diagnostic value in classifying varieties. Nine *mung* varieties were separated and were being classified.

In BENGAL, work on these crops remained in progress. Attempts at interspecies crosses between *mung* and *mashyam kalai* were being made to increase the yield of *mung*.

In ASSAM at Jorhat Station, seventeen selected varieties of *matikalai* and three of *mung* were under observation. Variety B gave the highest yield, but the results were not significant.

In the PUNJAB at the Dry Farming Research Station, Rohtak, black *urid* which failed last year gave better yield this year than the brown or Pusa black *urid*. The seed of black *urid* was obtained from the Riarki tract of the Gurdaspur district.

The average outturn was 430 lbs. per acre as compared with 340 lbs. of brown *urid*.

Mung was also under trial in COCHIN.

Soybean (*Glycine max* (Linn.) Merr.). The cultivation of soybean in the BOMBAY PRESIDENCY was gradually increasing. The yields varied from 350 to 600 lbs. and 1,400 lbs. to 1,800 lbs. per acre in the dry and irrigated areas respectively. The popularity of the crop depended on the development of a market for the produce.

TRAVANCORE. This was tried at Alwaye, Konni and Puliyara. In addition to the seed supplied from crops raised at Government Farms, 308 lbs. of seed imported from the Madras Presidency were distributed among 154 ryots for trial.

BURMA. In the West Central circle, Magwe, Large Pearl, Little Pearl and Black Bean were under trial. They gave poor results on account of wide spacing. They will be grown again with narrower spacing in the coming season.

MADRAS. At the Agricultural College, Coimbatore, fifty varieties were under trial.

ASSAM. At the Jorhat Station, only one variety was under observation and it did very well. Soybean is expected to be grown in all high lands of Assam as a *kharif* crop.

CHAPTER IV

FRUIT DEVELOPMENT*

THE horticultural work done during the year under report in the various provinces of India is briefly discussed below :—

(1) *Production of Nursery Stock.* Probably the most important factor in the development of the fruit industry is the supply of fruit plants of reliable parentage either at reduced rates or free of cost. The efforts of the Department of Agriculture, KASHMIR, are notable. For the last four years, on an average, 160,000 grafted fruit plants have been issued annually free of cost or at a nominal price. In order to consolidate scattered plantations into regular orchards, not less than fifty plants are distributed per individual grower. In MADRAS, 70,083 mango, citrus and sapota, 58,454 pine-apple suckers and 6,313 plantain suckers were supplied during the year. In COCHIN, 1,806 mango grafts, 288 sapodilla grafts and 17,789 pine-apple suckers were sold. The BARODA State Horticulturist sold 957 plants and 2,850 papaya seedlings. The Horticulturist of His Exalted Highness the Nizam's Government, HYDERABAD, extended nurseries for fruit plants, ornamental trees and shrubs and annuals at the various departmental farms and supplied during the year 4,553 fruit plants, 42 lbs. seed of vegetables, 5 lb. seed of flowers and more than a thousand ornamental shrubs. In SIND, the Department of Agriculture, in co-operation with selected zamindars, has established a number of demonstration orchards on privately owned lands. These orchards are from four to six acres in extent and receive a free supply of fruit stock from the Government Fruit Farm, Mirpurkhas, on certain conditions regarding maintenance,

* The assistance of Sardar Sahib S. Lal Singh, B.Sc. (Hons.), M.Sc. (Calif.), Fruit Specialist, Punjab Agricultural College, Lyallpur, in the preparation of this Chapter is gratefully acknowledged.

supervision, etc. The orchards are entirely maintained by the zamindars on whose lands they are situated, but are supervised and worked under the direction of the Horticulturist and his staff. Twenty-one such demonstration orchards have already been established. The total number of plants and cuttings issued during the year comes to 25,246. In the PUNJAB, the Department of Agriculture has established fruit nurseries at various agricultural farms to meet the growing demand of the public for fruit plants propagated from trees of outstanding merit. In addition to these Government nurseries, there are about a dozen other privately owned nurseries on the approved list of the department, which also supply fruit plants, but of late the demand has increased so rapidly that departmental nurseries could meet only a small portion of the total requirements. During the year 1936-37, 20,865 plants were distributed by Government nurseries against a demand of over a lakh of plants.

(2) *District and Advisory Work.* Considerable amount of advisory work on selection of sites, layout of gardens, etc., was reported by various horticulturists, especially in the Punjab, Bombay, Madras and Sind. Demonstrations were held on various farms, and at shows and public meetings. Short courses for the teaching of horticultural operations and fruit preservation were also popular in some provinces. Advisory work in fruit gardening is of the utmost importance, because, unlike annual farm crops, mistakes once committed in fruit gardening cannot be easily rectified.

(3) *Fruit-growers' Organizations.* It is gratifying to note that there is a move to organize fruit-growers into district or provincial associations in various provinces. In the PUNJAB and the UNITED PROVINCES, Fruit Development Boards have been constituted and have already begun work for the uplift of fruit industry. The Punjab Fruit Development Board has started a fruit journal which has been well received in the Punjab as well as outside.

Research Work

(1) *Propagation.* Work on the improvement of propagation methods is in progress at several research stations in India. The aim has been either to standardize methods already in use or introduce some others yet unknown to Indian nurserymen. In the PUNJAB and MADRAS, some aspects of propagation are being investigated incident to the propagation of plant material for experimental purposes. In Madras, such investigations are made in case of citrus and mangoes with special reference to (*a*) the relative merits of various methods of vegetative propagation, (*b*) the season to perform the operations and (*c*) the method of restricting variability in seedling root-stocks. In BIHAR, of the various methods of budding and grafting tried in case of mangoes, only the most common method of grafting by approach, *viz.*, inarching, gave encouraging results. In the PUNJAB, inarching of the mango is the method so far employed commercially, yet budding has given encouraging results which may at least prove useful in top-working inferior varieties. The budding of mango seedlings has succeeded to a remarkable extent in SIND, being 60 per cent success last year and this method has now replaced the method of inarching. The American method of budding citrus plants by inserting the bud with a slice of wood attached to the bud shield has been experimentally compared with the Indian method of inserting the buds without wood-piece both in Madras and the Punjab. In MADRAS, the results of a season's trials in case of one scion variety (Chini orange) and one root-stock variety (Guntur sour orange) are in favour of the American method; but in the PUNJAB, similar experiments carried out during three budding seasons in case of four scion varieties showed that the Indian method was slightly better than the American method (about 25 per cent more success in budding). But by the American method, it was possible to bud about 25 per cent more plants in the same time. Furthermore the American method gave better results when dealing with rather immature budwood than with mature budwood.

With certain fruit plants like grape fruit and *ber* (*Zyzyphus jujuba*), however, where the buds are associated with the presence of thorns that render the separation of bud from the wood difficult, the American method can be employed with greater advantage. The difference in the efficacy of the two methods tried in Madras and the Punjab may be due to (*a*) differences in environmental conditions, (*b*) differences in the material used in carrying out these investigations and above all (*c*) the skill of the budder, for, with unskilled budders, the American method has given better results than the Indian method even in the Punjab.

The viability of papaya seed is shown to have deteriorated in Madras after even a fortnight's storage.

(2) *Root-stock Investigations.* The research stations in the Punjab, Madras, Bihar, the Central Provinces, the United Provinces and British Baluchistan have already taken up root-stock investigations. In the UNITED PROVINCES, a series of apple stocks obtained from East Malling has been under test and the two aphis-resistant stocks, Merton 779 and Merton 793, have proved to be vigorous growers and have maintained their resistance to Woolly Aphis. Several other Malling stocks would have been valuable but for their partial susceptibility to Woolly Aphis. In BIHAR, the mango root-stocks S 12 and S 13 (both local seedling selections) are showing a significant difference with regard to their influence on the growth of scions grafted on them. S 12 is proving a vigorous root-stock and S 13 a dwarfing one. In MADRAS, differential ' take ' observed by the use of sweet orange and acid lime scions on the same root-stock varieties indicated that different scion varieties respond differently on a given root-stock variety. The root-stock varieties also differ in regard to the percentage of apogamic embryos, the percentage of germination and vigour and extent of variability in the nursery stage. In the PUNJAB, after a careful preparation of the material extending over four years, some root-stock trials have been laid out according to the Fisherian technique to investigate the influence of several important

root-stocks on sweet orange (Malta), mandarin (Santra) and grape-fruit. In preparing further material to study some other aspects of root-stock problems, the root-stocks will be under close observation with regard to such points as go to make them commercially important.

(3) *Improvement of Fruit Crops by Breeding, Selection and Artificial Pollination.* The collection of about 130 grape-vine varieties from various countries of the world formed the nucleus for experiments on the trial of varieties and the evolution of new varieties through hybridization at Lyallpur in the PUNJAB. In MADRAS, the selection of papaya seedlings on the basis of their vigour in the nursery has been shown to be an unsafe method to ensure the optimum number of female trees of early flowering. In the UNITED PROVINCES, the Maynard plum is self-sterile and for getting commercial crops from this variety, *P. Pissard* has proved to be the best pollinator.

(4) *Physiological and Cultural Observations.* As a result of a study of shoot-growth in clean *versus* grass cultivation in the case of mangoes, it was found in BIHAR that the leaf-area and shoot-growth were higher under clean cultivation than under grass, but the leaf-area per unit of length was higher in the case of the latter treatment. The trees under grass gave a heavier crop than those under clean culture showing that fruitfulness was directly related to leaf-area per unit of length. Mere comparison of leaf-area figures or shoot-growth did not give any clue to fruitfulness.

At Lyallpur in the PUNJAB, experiments on the relation of growth to fruiting in the case of Langra mangoes have been in progress for several years. The results indicate (*a*) the importance of early cessation of growth in summer for fruit-bud formation, (*b*) shoots that continue growing till late in the season (end of September) do not differentiate fruit buds, (*c*) fruit-bearing shoots do not make extension growth and consequently do not bear in the following season, (*d*) de-blossoming the shoots forces them to make extension growth in the same

growing season, and the de-blossomed shoots bear a crop in the following year. This strongly suggests that de-blossoming or light thinning out of one-year old shoots may considerably solve the problem of alternate bearing in mangoes.

Fruit-thinning experiments carried out in the case of apples at Chaubattia in the United Provinces revealed that thinning of fruit by 50 per cent improved size, colour and quality of the remaining crop. A premium of Rs. 1-3-0 over the control per maund, on the average, was fetched in the open market as a result of thinning, showing thereby that it is worth while resorting to fruit thinning in case there is a demand for select fruit in the market. Experiments conducted in the mulching of a peach grove showed a significant decrease in the amount of fruit-drop from mulched trees. The data, however, gave no conclusive results for crop-weights. Fruit-thinning experiments with peaches, carried out in the North-West Frontier Province, show that 700 fruits per tree was the optimum number. From 500 fruits per tree there is an increase in yield up to 700, but from this level onwards to 900 fruits per tree the yield remains constant.

In the North-West Frontier Province, an experiment with nitrogen, phosphorus and potassium singly and in combination showed that the treatment with nitrogen, phosphorus and potassium together was consistently best—nitrogen, potassium or phosphorus applied alone depressed yields. Of the double combinations, nitrogen and phosphorus did better than potassium and phosphorus, or potassium and nitrogen. Double green manuring, *i.e.*, *shaftal* in *rabi* and *arhar* in *kharif* was consistently better than single.

The results of an experiment on the effects of various degrees of dormant pruning on the cropping and vegetative vigour of *phalsa* (*Grewia asiatica*) carried out in the Punjab for a period of six years have established that light pruning of bushes (heading them at $3\frac{1}{2}$-4 feet above ground level) is the best in every respect in case the planting distance of the bushes is kept at ten feet each way.

An observation on the extent of sun-burn was made in the Punjab by comparing some fully protected and some partially protected santra plants (protection being given by the presence of *jantar* (*Sesbania aegyptiaca*) plants near the santra plants) with other plants of the same variety that were not provided with any kind of protection against the sun. The percentage of affected fruit on fully protected, partially protected and unprotected trees was 2·1, 12·9 and 22·5 respectively, suggesting that the damage can be almost prevented by growing a *jantar* hedge near the plants on the south-western side.

With a view to hasten the period of ripening in the case of grapes, some ringing experiments have been and are still under way at Lyallpur. Ringing of canes at different stages of fruit development has shown that fruit ripening is hastened by ringing. Ringing fifteen days after the berries had set, hastened ripening the most, *i.e.*, by eight to ten days.

The existence of an admixture in almost all the rows of grape-vine varieties, numbering about 130 in all in the collection at Lyallpur (Punjab), necessitated the detailed study of their morphological characters for points of such practical importance as (*a*) proper identification and naming of varieties, (*b*) removal of rogues and (*c*) purchasing varieties true to name. This investigation has been in progress since 1933 and the results up-to-date have been written up for publication. Investigations are in progress at Mirpurkhas in SIND on the best methods of trellising and pruning grape vines.

(5) *Fruit Preservation and Fruit By-products.* Fruit preservation is a necessary adjunct to fruit-growing, as surplus crops can be disposed of at remunerative rates if methods of preservation are standardised and suitable recipes for making the fruit products are worked out. This branch of fruit industry has received considerable attention in the Punjab for several years past. The fruit-products laboratories at Lyallpur are better equipped than any of their kind in India and several fruit products of as high a quality as the most popular foreign

brands are prepared on a semi-commercial scale. Investigational work on canning of fruits and vegetables, bottling of juices and squashes, etc., has been in progress. An advanced (post-graduate) course of seven months' duration is offered on the subject. A Fruit and Vegetable Preservation Scheme at Lyallpur (Punjab) is financed jointly by the Imperial Council of Agricultural Research and the Punjab Government. The lines on which work was continued during the year are mentioned below :—

(i) Determination of vitamin C content of citrus fruit squashes.

(ii) Standardisation of a fairly satisfactory method of preparing *jaman* syrup.

(iii) Preparation of *phalsa* juice and syrups by different methods. Use of nitrogen and concentration by freezing considerably checked deterioration in taste and flavour.

(iv) Satisfactory methods of preparing tomato juice and tomato ketchup were evolved and the products prepared compared favourably with the imported ones. Results have already been published in a special bulletin of the Punjab Agricultural Department.

(v) Experiments were also conducted on (*a*) the right stage of maturity of Bortlett Pear for canning, (*b*) preservation of malta and santra juices by concentration in vacuo and by freezing and (*c*) canning of four varieties of grape-fruit and eight varieties of pear grown at Lyallpur.

Samples of various products standardized so far like tomato ketchup, tomato juice, lemon squash, lime-juice cordial, orange squash, canned pear, pear jam, etc., have elicited favourable opinions from the public and provision-dealers. Fruit products like orange squash, lemon squash, marmalade, tomato ketchup and tomato juice have been prepared on a

semi-commercial scale to work out the economics of the same. As a result of the impetus given by the Punjab Agricultural Department and the Imperial Council of Agricultural Research, fruit preservation, especially the manufacture of citrus squashes, is being taken up on a commercial scale by several firms.

In the NORTH-WEST FRONTIER PROVINCE, drying of peaches in the sun has been tried but without success due to great humidity prevailing in July and August when peaches ripen. In September and October when pears ripen, conditions become favourable for sun-drying. Sun-dried Lecoute pears elicited a favourable report from the London market and were valued at 45*s.* per cwt. Fruit products like lemon and orange squashes, canned peaches, plums, apricots and pears, jams of various kinds and tomato juice prepared during the year found a ready market. Experiments on the manufacture of fruit paste were undertaken. The flavour, colour and keeping qualities of the product are satisfactory, but the problem of consistency and adherence to the containers has not yet been solved. The disposal of fruit in the form of paste would obviate the necessity of spending eight annas a maund—marketing charges on fresh fruit—and the fruit could be disposed of at leisure provided, however, the Indian consumers develop a liking for fruit paste.

(6) *Harvesting, Storage and Marketing of Fruit.* Work on the cold storage of fruit is in progress at Poona in the BOMBAY PRESIDENCY. The following are some of the main results :—

(*a*) Fully ripe and yellow Nagpur oranges can be kept in good condition for three months at 40° F. without any appreciable wastage. Malta oranges at 40° F. kept for four months.

(*b*) The suitable range of temperature for storing the Alphonso mango is between 45° F. and 48° F. Between these temperatures it will keep for seven weeks.

(*c*) The best stage for putting the Alphonso mango in cold storage is the so-called ' B ' stage when the fruit is fully developed but still green.

(*d*) In addition to the Alphonso variety, the following varieties give promise of good keeping quality in cold storage :—

Peter from the Madras Presidency, Fazri Zafrani from the United Provinces, Pairi, Cawasjee Patel and Farnandez from the Bombay Presidency.

(*e*) Peaches from the North-West Frontier Province kept well at 35° F. for a month.

(*f*) Bananas (Basrai) required 60° F., chikus 52° to 56° F., litchies 30° to 35° F.

(*g*) Apples from Chaubattia kept well for several months at 32° F.

(*h*) Seed-potatoes could be kept for ten months at 25° F.

Marketing problems of fresh, dried and preserved fruit are being tackled in the NORTH-WEST FRONTIER PROVINCE. Till 1935 the peach-growers in the North-West Frontier Province could make Rs. 300 to Rs. 500 per acre, but on account of the increase in area under this fruit, the returns have gone down to Rs. 80—Rs. 100 per acre.

Of the five varieties of grapes grown at Peshawar, only Kishmish and Bedanah travel well and ripen in June, *i.e.*, before Baluchistan grapes are available. The fruit of these varieties was sold in Calcutta market at Rs. 20 per maund excluding packing and freight charges.

(7) *Pests and Diseases.* In the United Provinces, survey and investigation of diseases of deciduous fruits were continued. Eight diseases of apple including three storage diseases, seven diseases of pear including two storage diseases and two diseases of peach have been added to the list of diseases occurring in the previous season. Infection experiments were carried out with *Coniothecium* species and *Corticium salmonicolor*

which cause the stem black and pink disease of apple trees respectively.

In the PUNJAB, the wilt of citrus trees, which by inoculation experiments has been proved to be due to a species of *Fusarium*, was studied in the laboratory. Inoculation experiments were conducted to find out if the fungi causing wither-tip of citrus trees (*Colletotrichum gloeosporioides* and *Gloeosporium limetticolumn*) could attack mango plants and *vice versâ*. The results so far obtained show that *Colletotrichum gloeosporioides* and *Gloeosporium limetticolum* can attack mango plants. The comparison of the three fungi, *viz.*, *Colletotrichum gloeosporioides*, *Gloeosporium limetticolum* and *Gloeosporium mangiferae*, was done in culture.

The citrus-canker organism (*Phytomonas citri*) was isolated and studied in the laboratory. In order to control the onslaughts of San Jose Scale, the Kashmir State Department of Agriculture has promulgated the Crop and Plant Regulation in terms of which particular tracts have been placed under quarantine for a period of five years to begin with. Where the Crop and Plant Regulation would operate, spraying of fruit plants is made compulsory for every owner or occupier of an orchard and restrictions are imposed on the import and export of the live-plant material.

CHAPTER V

FODDER CROPS AND GRAZING*

FODDER supply and grazing were subjects of discussion at three conferences held during the year under report. The first of these was the Preliminary Conference on the Better Utilisation of the Forest Areas for Grazing held at Madras in December, 1936, presided over by the Inspector-General of Forests with the Government of India. This conference was attended by representatives of the Forest Department from several provinces. The object of this conference was (1) to examine the existing methods of management of forest grazing areas for suggesting measures to provide the best type of grazing for the preservation and improvement of the best type of cattle and (2) to explore the possibilities of utilisation and development of ravine and derelict lands outside Government forests for grazing so as to increase fodder resources. Reports and papers contributed by Forest Officers from several provinces enabled the conference to go into the question of grasslands at length from different aspects, such as the total area available, incidence of grazing, cattle population, grazing rights of the public and ownership of grazing areas, etc. The discussions made it clear that forest grazing was of minor importance, as the grazing area under the control of Forest Departments was not extensive in comparison with that under Revenue authorities and private ownership. The area under Forest control was only three per cent of the total grazing area in the country. Therefore, for any increase in fodder supply great attention would have to be paid to the improvement of derelict and waste lands.

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* The assistance of Prof. L. S. S. Kumar, M.Sc. (Lond.), A.R.C.S., D.I.C., Economic Botanist to the Government of Bombay, Agricultural College, Poona, in the preparation of this Chapter, is gratefully acknowledged.

The following were the recommendations of the forest conference:—(1) there is considerable scope for improvement in the quality and quantity of forest grazing, especially of the type of lands which carry pole-scrub and thorn-forest at present, provided watering facilities are made available, (2) improvement is possible only if scientific management by competent staff is provided, (3) the periods of closure and grazing should be controlled if necessary by legislative measures, (4) the expenditure on the improvement of grassland will probably not be immediately remunerative and the ultimate return will probably be indirect, hence this expenditure should be provided by the Governments concerned without adding this as an additional burden upon the budgets of the departments directly involved, (5) there is a great scope for improvement of grazing areas outside the orbit of the activities of technical departments by the introduction of proper management and (6) the organisation and improvement of such lands should be vested in a Provincial Fodder and Grazing Committee which the conference recommended should be established in every province.

Following this Preliminary Conference of Forest Officers, the Second Meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India was also held at Madras in December, 1936, in which the recommendations regarding the questions of better utilisation of forest areas for grazing were considered.

In the ensuing discussion the following points were suggested as requiring attention:—inclusion of a botanist and agriculturist on all Provincial Fodder and Grazing Committees; provision of better grazing areas easily accessible to the village breeder; proper management of what is commonly known as cultivable waste; undertaking of comprehensive research work to improve the condition of grasslands; reservation of more areas for grazing wherever unremunerative crops were grown extensively; legislation for restricting the number of animals admitted to grazing areas; admission into the forest grazing areas to be restricted to animals certified to be free from

rinderpest; castration of scrub animals; increasing the fee for male animals over a certain age and leasing of lands for grazing on condition that hay and silage are also prepared.

The Board after making certain modifications adopted the recommendations of the Preliminary Conference of Forest Officers.

The Animal Nutrition Sub-Committee of the Board discussed the question of fodder and fodder resources from two aspects, *viz.*, cultivated fodder and natural pastures. The committee decided that economic and scientific control of forest and other natural grazing areas was of prime importance since it was directly connected with the fodder problem of India. Accurate statistics in regard to acreage under different fodder crops from all provinces were required in order to find out the deficiency of fodder resources so that necessary steps might be taken to increase the area under fodder crops. For this purpose a questionnaire was prepared by the Sub-committee to obtain the information.

The possibilities of utilisation of surplus molasses as cattle-feed were next considered by the Sub-committee. It was decided that more experimental work was necessary to determine the food-value of molasses before it could be advocated for replacing part of concentrate and roughage fed to cattle.

At the Board meeting the recommendations regarding circulating the questionnaire, for obtaining a statement showing available fodder crops for the stock of each province preferably district by district, were discussed and it was agreed that a Sub-committee of the Advisory Board of the Imperial Council of Agricultural Research should examine it before it was circulated. In addition to the recommendation for the establishment of fodder and grazing committee in each province, the Board approved of the recommendation for the establishment of a Central Fodder and Grazing Committee of the Imperial Council of Agricultural Research for co-ordinating the work of the provincial committees.

At the Cattle Conference held in Simla during the last week of May, 1937, improvement of grasslands, better utilization of waste and surplus lands for fodder production and the initial steps to be taken towards their improvement received prominent consideration. A large number of representatives of the different provinces including ministers took part in the discussion. This conference endorsed the recommendations of the previous two conferences referred to above and urged the establishment of Central and Provincial Fodder and Grazing Committees.

Imperial Agricultural Research Institute

THE work on fodder and forage crops was continued. As in previous years it was found that imported fodder grasses do well in the monsoon when other fodder grasses are already available in abundance and they are of no value in hot weather and in winter when there is a scarcity of grasses. Berseem is found to be the best irrigated winter fodder crop for the milch herd and *guar* (*Cyamopsis psoraloides*), *meth* (*Phaseolus aconitifoliüs*), and soybean as hot weather and monsoon fodders.

The grazing cycle of green fodder, which was found suitable for the dairy herd after many years of trial at Pusa, is being followed at the New Delhi Institute also.

Intensive investigations on silage-making have clearly shown that the maize silage suits the dairy herd better than any other silage. Berseem also has been found to make good silage.

Animal Nutrition Section, Izatnagar

CONSEQUENT on the transfer of the section from Bangalore to Izatnagar, the animal feeding work was discontinued for the time being. During 1936-37 attention was mostly devoted to the completion of the work started in the previous year.

Sulphur Content of Grasses. A study of the sulphur content of Indian grasses has been completed. Amongst grasses growing side by side in the natural state, it was noticed that the

species of the tribe *Chloridae* contained more sulphate than the others. The stalks of grasses contained more sulphate than the leaves. In the case of lucerne, the reverse was true.

Maintenance Ration for Hill Bulls. One feeding experiment for the determination of the maintenance requirements of hill bulls was carried out during 1936-37. The digestion tests were conducted to find out the digestibility of the fodder and the nitrogen and mineral balance of the animals.

Imperial Dairy Institute, Bangalore

EXPERIMENTS on the carotene contents of grasses and concentrates, by the feeding of Guinea grass to dairy cows, gave inconclusive results and further intensive work is required. From the work done it can be generally concluded that the carotene of the grasses and feeds supply all the vitamin A demanded by milch cattle.

The monsoon crop consisted of *jowar* (Sorghum) and a variety of perennials, *viz.*, Sudan, Napier, Rhodes and Guinea grasses. Of these, Sudan and Napier grasses were introduced during the year and they did well. Teosinte was tried during the monsoon season of 1935-36 and it was found that it did fairly well in monsoon but failed as an irrigated crop. *Jowar*, being a good material for ensilage, was grown mainly for silage-making.

Due to favourable rainfall and the availability of irrigation water for a longer period, the production of green fodder was far in excess of the amount produced in the previous two years.

Trench silos were used and were found to be the most suitable in every respect and particularly suited to the local soil and water conditions.

Jowar and maize are found to be the most suitable crops for the *kharif* season both for feeding green and for silage, and oat and mixture of peas and oats for the *rabi* season. These crops have been found to give large yields and at the same time are economical to grow.

Imperial Council of Agricultural Research

INDIA was represented by the following officers at the Fourth International Grassland Congress, held in July, 1937 at Aberystwyth :—

Mr. J. A. Wilson, Deputy Conservator of Forest, Madras,

Mr. E. J. Bruen, Livestock Expert, Bombay,

Mr. E. A. H. Churchill, Principal, Agricultural College, Nagpur, Central Provinces, and

Professor L. S. S. Kumar, Economic Botanist to the Government of Bombay, who was deputed by the Imperial Council of Agricultural Research to attend the Congress.

Central Fodder and Grazing Committee. An *ad hoc* committee consisting of representatives of different provinces was formed under the aegis of the Imperial Council of Agricultural Research with a view to co-ordinate the work in the provinces and to suggest measures for conducting experiments on the improvement of fodder resources and grasslands.

This committee met for the first time in November, 1937 in New Delhi. After two days' discussion the committee resolved on the following action :—

(1) Preparation of a short annotated bibliography on what has been published in India on (i) grasses, grasslands and fodder trees, (ii) feeding tests carried out in India and (iii) erosion in connection with grazing problem with particular reference to work done in India. (2) Preparation of an accurate estimate of the amount of food for livestock available from all sources. (3) Drawing up of a complete list of cultivated fodders with details of their varieties, cultivation methods and yield. (4) Inclusion in each provincial fodder and grazing committee of a botanist who is familiar with grasses and ecology. (5) Simplicity in grazing experiments.

The Committee adopted the recommendations of Sir John Russell and Dr. Wright regarding fodder made in their respective reports.

Consequent on the discussion of the reports of Dr. Wright and Sir John Russell, the Committee considered that the growing of high-yielding types of crops available as the result of the activities of plant breeders should release a certain amount of land for fodder growing.

The Committee next considered the report of Prof. L. S. S. Kumar on the International Grassland Congress held at Aberystwyth. After enumerating his impressions of the tour through grassland areas of Great Britain, Prof. Kumar emphasised the importance of starting long range research on (1) grassland herbage, (2) systems of grazing, (3) fertility of the soil, (4) conservation of fodder and (5) soil conservation. Under herbage improvement, strain-building by breeding and selection was stressed. Mr. Bruen's report, besides covering the points mentioned by Prof. Kumar, mentioned that molasses added to silage made it more palatable and a great deal cheaper than the silage made by the A. V. I. and whey methods. Still more interesting information was that poultry following cattle on pastures which are heavily manured had a very beneficial effect in that cattle would eat such pastures, whereas they would not do so if not followed by poultry.

The Committee next considered two schemes received from the Government of Bombay and the United Provinces respectively on grassland improvement. The Bombay scheme was restricted to rotational grazing in tracts of different rainfall and ecological studies of grasses, while the United Provinces scheme was more exhaustive and included the improvement of *usar* lands (lands impregnated with alkali salts), development of fodder, nutritional studies, etc., to be carried out jointly by the Agricultural, Forest and Veterinary Departments. Both the schemes were approved after suitable modifications and were recommended for the consideration of the Advisory Board.

A short account is given below regarding the principal features and problems of the various provinces:—

ASSAM. Fodder crops are grown in rotation with potatoes. Maize, *raishan* (*Paspalum sanguinale*), cowpeas, soybean and mixed grasses were the principal fodders grown. Maize gave a poor yield. The cost of producing silage per maund was as follows:—

Maize Rs. 0-8-2, grass and *raishan* Rs. 0-2-0, dry hay Rs. 0-7-0 and *raishan* green Rs. 0-2-4.

Fodder plots were started in cultivators' lands in village breeding areas. Guinea grass and Napier grass were mainly grown in their plots.

The usefulness of aquatic grasses as fodder in low-lying parts of the province has been realised and preliminary investigations into the quality and utility of different varieties have been started by the Live-Stock Inspector, Sylhet. Some interesting facts have already emerged from the preliminary investigations.

In many of the farms the main stand-by for fodder during dry season is silage made in *katcha* (made of mud) pits. Many of the fodder crops are turned into silage.

Kikuyu grass, a native of South Africa, has succeeded at the Upper Shillong Farm and is being tried in the plains. It provides good grazing.

BENGAL. With the exception of Bankura, all district farms are self-supporting in respect of fodder. Napier grass is grown on all farms. Silage is made at all district farms for feeding. Demonstrations of silage-making were given by the Live-stock Officers at all farms. Over 20,571 maunds of silage were made at Dacca against 16,441 maunds of the last year. The cultivation of Napier grass is extending and a large number of cuttings have been issued. One of the great difficulties in Bengal has been to induce cultivators to grow green fodder for their cattle. This difficulty has been overcome to a great extent

by the introduction of Napier grass, which is a very heavy-yielding perennial. As it can be grown on areas at present not under cultivation, it is accepted by the cultivators, whereas annuals which encroached on rice and jute lands are not accepted as they do not bring any direct revenue. If cattle are to be kept in good condition, large areas under green fodder in every district are necessary. Paddy straw, which is the main fodder of the province, needs to be supplemented with green fodder as a maintenance ration. The fact that over 35 lakhs of Napier roots and cuttings have been distributed indicates that cultivators are gradually taking to fodder cultivation and are realising the necessity for green fodder throughout the year to keep their stock well fed and in good condition.

The statistical work on the yield of green matter of American cowpea, Perudal and a local variety proves that the American varieties Groit and Perudal are the best as regards yield.

It has been decided to retain the late heavy-yielding types of *jowar* only. The Rajshahi late type has been multiplied for the distribution of seeds in the districts.

From the comparative study of yield of American ensilage maize and Kalimpong maize types, it has been found that the Kalimpong type, White Dent, is more suitable for Bengal.

The work on pasture grasses is being continued as in the last year. *Andropogon pertusus* and *Andropogon annulatus* proved their superiority to other grasses last year also and *Panicum abyssinicum* remained green throughout the whole season.

BIHAR. Trials have shown that under Chota Nagpur conditions the addition of minerals to the feed of the cattle improves their general health and condition. The difference between the better and poorer types of cattle in different parts of the province is mostly attributable to differences in minerals in the fodder available. In order to investigate the relationship

between the fodder and the health and condition of animals with particular reference to mineral deficiencies, investigations have been commenced since 1936, financed by the Imperial Council of Agricultural Research. The investigations include analysis of fodder for mineral contents, influence of the age of fodder on the mineral contents, chemical composition of the fodder in relation to the soil on which it grows, seasonal variation and the effect of cultivation and manuring on the composition of fodder. The fodders to be analysed include maize, *jowar*, teosinte, *meth*, soybean, peas, oats, *kusum* (*Carthamus tinctorius*), chicory, *kalai*, *khesari* (*Lathyrus sativa*), cowpea, *guar*, safflower, *kulthi* (*Dolichos biflorus*), val, *barai*, berseem, lucerne, Elephant grass, Guinea grass, *dub* grass, forest grasses, paddy straw, wheat, barley *bhusa* (straw), sugarcane leaves, etc. The investigation has not proceeded far enough to draw any conclusions.

BOMBAY. The large scale rotational grazing experiment conducted by the Economic Botanist to the Government of Bombay, Poona, was continued during the year. Owing to the total failure of the monsoon, the experiment not only commenced late but had to be closed much earlier. In consequence, the grazing period was cut short by more than half.

A few years' trials have indicated that a certain amount of grass growing under shrubs is not available for grazing and thus is wasted. By lopping off the lower branches of the shrubs it was observed that nearly two pounds of semi-dry grass was available for grazing under each bush.

A grazing *kuran* in Satpur near Nasik was surveyed for starting rotational grazing experiment. The grazing experiments at the Gilligan Cattle Breeding Farm could not be commenced on account of failure of the rains.

Two varieties of drought-resistant Brazilian grasses, *viz.*, Gordura and Jaragway, which were introduced on Bankapur Farm, did not make much growth in the first four months. Efforts are being made to grow these on pasture lands.

Elephant grass was grown on twenty-five *gunthas* and gave 20,427 lbs. of green fodder from ten cuttings. Two *gunthas* of Guinea grass yielded 656 lbs. of green grass. Most of this was turned into silage. Grasses from Bangalore were discontinued since they were not any better than the local grasses.

Of the two varieties of soybean grown on the Farm, Large Yellow has proved superior to Mammoth Yellow and it is proposed to grow a larger area under the first-named.

CENTRAL PROVINCES. The work in connection with the improvement of fodder grasses has been in progress and the effect of different fertilizers on the botanical composition of the herbage was determined at the Telinkheri Farm. During the year, a large quantity of improved grass seed mixture was collected and supplied to the Deputy Director of Agriculture, Northern Circle, for the improvement of "Bir" land at Jubbulpore. Selected types of some of the chief varieties of grasses were grown on the College Farm, Nagpur for demonstration and distribution of pure seed. All the selected types of soybeans were grown on a large scale to meet the demand of improved seed.

Chemical examination of the grasses from the permanent experimental plots at Telinkheri was continued on the same lines as in previous years.

MADRAS. In a comparative test made between fodder sorghum and fodder maize at Coimbatore, it was observed that the tonnage of sorghum, grown between August and January, was poor when compared with that grown in the remaining months, whereas maize yielded fairly and uniformly throughout the year. It has been found best to grow maize from September to January and sorghum for the remaining seven months.

Sweet-potato vines, when fed to milch cattle as green fodder, resulted in marked increase in the yield of milk.

At Guntur, in addition to the usual fodders, *kollaganjeru* (*Ipomea hispida*), a well-known local fodder, was grown on a large scale during the cold season. *Pillipesara* (*Phaseolus trilobus*), a fodder legume, was also grown mixed with sorghum.

At the Hagari Farm, two species of salt-bush were under trial. One of them (*Atriplex nummularia*) grew well, but cattle did not relish it. At Koilpatti, with the application of night soil, compost and copious irrigation, Guinea grass gave a heavy yield of 67,000 lbs. per acre.

In all circles of the province, propaganda for growing improved fodder was conducted. New types of fodder, *viz.*, *pillipesaru*, teosinte, *kollaganjeru* and lucerne were introduced wherever suitable. *Kollukatai* (*Pennisetum cenchroides*), Elephant grass and Guinea grass are being spread in many districts.

Over 171,150 slips of Elephant grass and Guinea grass and 9,569 lbs. of seed of various fodder crops were distributed during the year.

PUNJAB. *Jowar* strains, JS 20 and 21 are found again to be the best and JS 21 is by far the best sweet-fodder type of *jowar*. Sudan grass, which is much favoured by the farming public, is in great demand. Multiplication of the seed of this grass is being organised to meet the demand. Teosinte has proved to be a useful fodder crop of the province and is gaining in popularity. Unlike other exotic crops, it sets good seeds, of which the yield is quite high. It gives a heavy yield of green fodder. The demand for planting material of Elephant grass, Guinea grass and Rhodes grass is increasing. Among early maturing oats, Pusa hybrid J gave the heaviest outturn of fodder, while the late and coarse types French and Golden Rain gave the best yield on rich soil with an ample supply of water. The finer types, Algerian and Strain 1/29, which are not exacting in their soil and moisture requirements, are found suitable under conditions where irrigation is restricted.

Work on *guara*, berseem, *meth*, *senji* (*Melilotus parviflora*), Japan rape, Kudzu vine and pasture grasses is in progress. An analytical survey of the fodder crops and grasses is being carried out in collaboration with the Agricultural Chemist to Government.

SIND. Berseem is found to be a suitable fodder legume for Sind and is useful for cultivation in crop rotation for the reclamation of *kalar* lands. It is an excellent *rabi* fodder crop and the area under it is extending. Work on water-requirements of berseem for cultivation as fodder and seed purposes is in progress. The results so far obtained indicate that 30-acre inches is required, which is twice as much as the requirement of a crop like wheat.

From monthly plantings beginning from July, 1936, and lasting for twelve months it was found that Sargrass (*Saccharum munja*) could be successfully transplanted up to the middle of October. The seeds germinate best in the summer months.

CHAPTER VI

RESEARCH IN CROP PRODUCTION*

1. Soils and Fertilisers

THE work on soils and fertilisers during the period under review was principally the continuation of what was commenced in previous years. It consisted of soil-surveys from irrigation and fertility points of view, investigations on soil-moisture and its conservation, and studies on the physical, chemical and biological properties of soils, and on the effect of manures and fertilisers on soils and crops. During the year under report, the transfer of the Imperial Agricultural Research Institute from Pusa to New Delhi was completed. A brief account of research and investigation on soils and fertilisers, carried out at Pusa during the past three decades, was included in the Annual Report of the Institute for 1936-37. The President of the Agricultural Section of the Indian Science Congress Session at Hyderabad in January, 1937, reviewed the progress

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in the Science and Practice of Agriculture in India and directed attention to some of the problems on soil-management and manurial and fertiliser practice in India.

The review is confined to a very brief description of the broad outlines of research and investigation in progress during the year in the different parts of India. More detailed information is available in the *Indian Journal of Agricultural Science, Agriculture and Live-stock in India,* and in the Annual Reports of the Imperial Agricultural Research Institute and of the research institutes and departments in the provinces and States.

Soils

Soil-survey. At the Imperial Agricultural Research Institute, New Delhi, a comprehensive survey of the soils of India was commenced. The survey has for its object the actual examination in the laboratory and the collation of the results with provincial data in regard to the physico-chemical reactions in the formation of soils and the genetic relationship existing in the profiles. Special attention was being paid to the influence of temperature, precipitation and evaporation on soil formation and profile characteristics. In this work stress was laid on the importance of uniformity in the description, collection and examination of profile samples.

In Madras, the area under the Cauvery-Mettur Project, comprised by the taluqs of Tanjore, Mannargudi, Pudukkotai and Papanasam in the Tanjore district, was under survey in regard to the suitability of the soils for irrigated crops other than paddy. Ninety-five per cent of the area has been found to consist of red clays and loams and the remaining five per cent of black soils near Tanjore town. The soils of the area were found to be poor in lime and to need supplies of organic matter over a long period. In the same province, the area under Kattalai high level channel project, in the Kulittalai taluq of Trichinopoly district, was surveyed with reference to development of alkaline zones. Saline areas developed in part of the

command due more to lack of drainage and rise of water-table than to the salt-content of water. Areas which were formerly under date forests and brought under irrigation recently showed as high a *p*H value as 10 and the soil contained large quantities of sodium carbonate and bicarbonate. The survey of the Gundlakanuma Project area under tank irrigation revealed a fertile alluvium growing good crops of paddy. The tail end of the area, however, consisted of salt swamps growing nothing.

In the Cochin State, the fertility survey of Trichur and Talapalli taluqs was completed and that of Mukundapuram taluq was commenced.

In Bihar, the soil-survey work, which was originally confined to departmental farms, was extended to districts, the object being to tender advice to cultivators.

The genetic soil-survey initiated at Padegaon in the Bombay Presidency was extended to Pravara Canals. Profile examination indicated that the actual development of horizons or the differentiation of the profile into horizons depended largely on the depth of the soils. It was possible to establish the relationship of the soils examined with either of the two different groups of types of soil already designated under Godavari Canals. Analyses of clay fractions of the different soils yielded results similar to those for whole soils. Another kind of survey—the soil fertility survey—was commenced, to ascertain the origin, extent and nature of degraded soils as the result of irrigation and accumulation of salts. A relationship appeared to exist between the extent of degradation and the amount of total salts, calcium carbonate and soil reaction in the profiles. All soils having a zone of accumulation of total salts exhibited the characteristic lumpy or clod-like structure and a higher degree of saturation with exchangeable sodium than those soils without such zones of salt accumulation.

At Chaubattia in the United Provinces, a survey of the soils of the fruit research station was carried out and a coloured profile map was prepared. The main soil forming rock of the station was stated to be biotite with Quartzose admixture.

At Coimbatore, studies on the origin of black and red soils were made. From the wide differences in the physical and chemical properties of these two classes of soils, it was considered that one soil could not have been derived from the other. The chief difference between the types lay in the SiO_2/R_2O_3 ratios of the clay fractions. Using a modified method for estimating Al_2O_3, black soils were found to contain no Al_2O_3, while laterite soils gave a high value and the red soils an intermediate value for Al_2O_3. From these results it was concluded that the origin of the black soils was connected more with the mineralogical composition of the parent rock than with the climatic or environmental influences during soil formation.

At Dacca, a study of the profile characters of soils, collected as laterite soils from different parts of India, was in progress. It was stated that full development into laterites took place in places where alternate wet and dry climate prevailed and that the decomposition extended to considerable depth. In places of more or less continued dry weather and evenly distributed rainfall, the decomposition was not complete and gave rise to red soils.

At the Pusa Institute, the effect of manuring and cropping on the vertical distribution of calcium carbonate in the soil was investigated. Two zones of high calcium carbonate concentration, with a zone of low carbonate concentration lying between the two, were developed as the result of manuring and cropping, while in fallow land a steady increase in calcium carbonate concentration was observed from the surface down to a depth of five feet. An interesting observation was that the total amount of calcium carbonate was constant within a five feet deep profile, the only change being in the distribution concentration in the different layers within the five feet depth. From the measurements of moisture equivalent, by the method of Briggs and McLean, the texture of the horizons appeared to vary with the carbonate concentration.

In Bengal, the soils of certain coastal areas of Chittagong district—Mahesh Kali, Bhadra Kali, Poke Kali—were observed

to overlie peats. The top soil, which varied in depth from three to twelve inches, was described as grey in colour and friable. The next layer from two feet to three feet from the surface was noted to consist of vegetable matter in a semi-decomposed state, of chocolate brown colour, and mottled with sulphur yellow crumbly deposits. So far, the occurrence of yellow deposits was noted mostly along the lie of roots. In the same province, but in the district of Bakarganj, underground pan was noticed. It did not appear to have formed from any concretionary material and appeared to be purely a clay pan impervious to water to a certain degree. The interesting observation about the pan was that it formed again after breaking up. The mechanical and chemical composition of the pan material did not show lines of demarcation between the top soil and the pan soil below.

In the Dacca University Scheme financed by the Imperial Council of Agricultural Research profile studies of soils obtained from Peninsular, Central and Eastern India have indicated, so far, some general characteristics. It is observed that the soil material in the surface horizon is light red and that there is a tendency to form honey-combed iron crust in such horizons. The surface horizons show slightly acid reaction passing to neutral and even slightly alkaline reaction in lower horizons.

Soil Colloids. The investigations on colloidal acids and hydrogen clays were continued at Calcutta. The Tinsley Potentiometer was used for potentiometric work, reading directly or hundredth of a millivolt. For *p*H determinations, glass-electrodes in conjunction with a Cambridge electrometer valve *p*H-meter was used.

With pure systems of silicic acid solutions, it was again found that (1) on the addition of a neutral salt, there was a sudden increase in the acidity of the ultrafiltrate and in some cases more acid was gradually liberated than was indicated at the inflexion points. Thus there was free acidity—different from the total acidity; (2) the existence of a definite cation

specificity, more in agreement with the order of their electric adsorption than with the order of their solubility, was noticed; (3) at higher concentrations, *i.e.*, higher *p*H, another inflexion point was observed at 11·05 *p*H indicating that the curves in the previous reports were incomplete and (4) the solution showed weak acid character whereas the electro-dialysed solution exhibited strong acid nature in the titration with NaOH, $Ca(OH)_2$, and $Ba(OH)_2$. An explanation for these was sought in terms of (1) a double layer, (2) adsorption of ions and formation of ion pairs in the interface, (3) the lattice energies holding the reacting ions to the surface and (4) the stability of anions of the acid substance in true solution.

Hydrogen clays prepared from different soils having varying base-binding capacities showed properties (1) and (2) above. The difference, in the total acidity values of sol. + $BaCl_2$ mixture, obtained on titration with NaOH and $Ba(OH)_2$, indicated that the titration was not merely a simple neutralisation of the hydrogen ions liberated by the barium chloride. Another interesting observation was that in the titration of solutions with Ca and Ba hydroxides an initial rise in the acidity was noticed, contrary to the notions on acid-base equilibria.

The free oxides of the soils were separated by the method of Truog and Drosdoff, but it had practically no effect on the acidity of the clays studied except in change of colour.

A comparison was made of the values for total acidity by the methods of Mattson, Parker, Hissink and electrometric titration. There was agreement between Mattson's and electrometric methods. Hissink's method gave high values due probably to the break down of the complex at the high alkalinity used in the method.

Soil Moisture. At Dacca, studies on the evaporation of water from soil in different parts of Bengal showed that the data conformed to the absorption equation developed in previous years. It was observed that the vapour pressures of the soils were different from the real moisture adsorption curves to the extent that they showed points of inflexion at low

moisture content. Above the point of inflexion, they were similar to the curves obtained in case of adsorption.

Continuation of soil-moisture studies on the Dacca Farm showed again fluctuation in moisture-content down to a depth of twenty-four inches. Below this depth, the percentage of moisture was fairly constant. The moisture profile was further studied by following up the movement of water added to the soil both as rain and irrigation. As would be expected, the level of constant moisture was raised.

Attempts were made to find out a method of calculating the value of the so-called imbibitional water and to form a picture of the different states of moisture in the soil. It was suggested that the moisture-content at the usual breaks in the Freundlisch isotherm or its derivative would correspond to imbibition moisture. It was further suggested that moisture at the maximum stickiness included the so-called truly capillary water and the imbibition water. Based on these two suggestions or assumptions, certain data were presented and discussed.

At Calcutta, studies on soil-water relations with respect to rice crop were in progress. Three different levels of soil-water relationships were under investigation. In one set a depth of three inches of water was maintained; in another the soil was maintained at a little over full saturation capacity with respect to water; in the third set, the soil was maintained at a level slightly lower than the saturation capacity so that the surface of the soil was cracked here and there. Over saturation and a constant sheet of water over the soil did not affect the rice plant. Frequent flooding and letting out water was beneficial to the plant.

Soil Phenomena. Experiments at Padegaon on continuous watering, manuring and cropping were found to bring about soil improvement by encouraging the formation of calcium colloid and diminishing the sodium colloid in the heavy soil.

The so-called *chopan* (heavy) soils, which are sodium saturated soils, and, therefore, unfit for irrigation under a perennial system, were submitted to base-exchange studies.

The results showed that under a judicious system of irrigation these soils were improved markedly.

The paddy soils of Raipur, in the Central Provinces, were found to contain increasing percentages of clay with depth. No particular relationship was noticeable between the clay-contents of the soils and the percentage loss on ignition. The lime-content of heavier soils was higher than that of lighter soils. Leaching for twenty-four to seventy-two hours resulted in the loss of nitrogen as ammonia, nitrite and nitrate. Leaching after treatment with sulphate of ammonia resulted, as would be expected, in greater loss of calcium in addition to loss in other soil constituents.

At Coimbatore, attempts were made to ascertain if any relationship existed between electrical conductivity of soils and crop-yields. No significant correlation was observed. Soils under continuous cropping between the years 1926-36 registered a steady fall in electrical conductivity over a seven-day period. Similar conductivity studies on several Tungabhadra soil-profiles showed normal seven-day increases for surface soils and insignificant values for lower layers. This was attributed more to the high salt-content and consequent decreased hydrolysis than to diminished bacterial activity in the deeper horizons.

Soil Analysis. At Dacca, the potassium permanganate method of mechanical analysis was further elaborated. The method as finally evolved consisted in the use of alkaline potassium permanganate for oxidising organic matter and the addition of grape sugar to remove the excess of permanganate. Then acidic ammonium acetate and sodium bisulphite to remove manganese dioxide, exchangeable calcium, calcium carbonate, etc., followed by final leaching with ammonium acetate. The loss in solution in this method was claimed to be less than that with the International method.

At the Imperial Agricultural Research Institute, an examination of the existing methods of mechanical analysis in regard to their applicability to highly calcareous soils showed

that the bulk of the calcium carbonate did not come into the clay fraction and that preliminary acid treatment was, therefore, unnecessary.

Soil Cultivation and Dry Farming Experiments. At Tocklai in Assam, the experiments on the effect of cultivation indicated that suppression of weeds was the factor of main importance in cultivation, whether it was carried on the surface or to increasing depths. Increase in the number of hoeings over five or six showed no greater good effect. Reduction below this number resulted in such jungle growth that the crop of tea was reduced greatly. Cheeling or simple scraping of the surface was equal in efficiency to that of light hoeing. Cultivation in the beginning gave better return than manuring. Later on, manuring scored heavily.

In the dry farming experiment station at Rohtak in the Punjab, appreciable differences in moisture conservation were observed between deep and shallow cultivation. Stirring after rain was observed to conserve moisture and inter-culturing gave a better crop of *bajra* than the control and with expense of less moisture. Cross bunding resulted in the better conservation of moisture with higher crop-yields than when no bunding was done.

At Raichur in Hyderabad (Deccan), the entire area of the dry farming research station was surveyed by making pits at distances of a hundred feet or closer, as necessary. Employing the improved Bombay method, described in previous reports, higher yields of grain and lower yields of straw than with the local system were obtained for *kharif* crops. The reverse was the case with *rabi* crops. The local method gave higher yields of grain than the Bombay dry farming method.

At Bijapur and Sholapur, soil studies were in progress with a view to develop improvements in the existing dry farming methods. At these stations the water retaining and delivering power of soils as also the penetration and loss of rain water were under investigation. For the Bijapur soils moisture equivalent correlated with clay-content. Lower layers of soils

showed higher values for all types of soils in the area. Hygroscopic moisture was also found to vary with clay-content of the soil. Nitrogen fluctuations in cropped and uncropped soils were found to be of the same order. On the field scale, yields of 100 per cent and 50 per cent grain and straw respectively were registered by the improved methods as against local methods. The improved method included the addition of farmyard manure along with other cultural methods.

At Hagari in Madras, soil studies with respect to their physical and chemical composition and moisture relationship were in progress. On the field scale, ploughing and bunding resulted in reducing from 90 per cent to 60 per cent the loss of moisture received as rainfall. Frequent intercultivation indicated moisture conservation. Mere weeding alone gave equally good results in the case of sorghum.

Soil Organic Matter. At Dacca, investigations on the organic constituents of soil were in progress. An Assam soil, very unusually rich in organic matter, containing nearly 79 per cent of organic matter on the weight of soil, was used.

The methods employed consisted of successive preliminary extractions with ether, benzene, alcohol and boiling water to remove waxes, hydrocarbons, sugars and pentosans. Hemicelluloses were removed by extraction with fuming hydrochloric acid. Each of the extractions required as much as one to two months. For further fractionations, the methods were based on the work of Page and Waksman for the isolation of humic acid and of Willstatter for the fractionation of lignin and humic acid. The C-N ratio fell after ether extraction due to the removal of carbonaceous matter like waxes; the ratio rose again after water extraction due possibly to the removal in the extract soluble nitrogen compounds.

Dacca and Madras soils were found to be too poor in soluble matters, while Assam soils were comparatively rich. On a number of soils tested, organic matter occupied approximately one-third of the value for loss on ignition. Certain soils, however, showed pronounced deviations.

At Tocklai in Assam, significant increase in soil nitrogen and organic matter was observed from the application of purely inorganic manures to tea. The magnitude of the increase was small, the greatest increase observed being 0·4 per cent.

Soil Acidity and Alkalinity. Work on soil acidity was continued at Tocklai. A *p*H of 5·5 was formerly regarded as about the optimum value for most tea soils. Recent work had shown differentiation depending on the type of soil. Thus a sandy soil with a *p*H of 5·6 would grow tea well, which on a stiff soil tea would not tolerate. The optimum acidity for tea would appear to lie somewhere lower than *p*H 5, seeing that *Bhil* soils grow healthy tea with a *p*H of 4·5 or less.

At Benares, it was observed that hydrogen ion drift occurred in soil medium growing plants, pointing to the interdependence of the soil and plant. It was shown that plant growth could induce considerable changes in the reaction of the soil substratum.

A soil with an acid or alkaline reaction need not, therefore, necessarily require lime to bring the soil's *pH* to neutrality, unless the initial *p*H was far above or below the range specific for the plant.

In the Punjab, field scale studies on the reclamation of *kalar* land were continued. Soils were reclaimed by flooding and washing, and that appeared better than green manuring. Wheat following berseem yielded 13 maunds 16 seers, while wheat following rice yielded 21 maunds 27 seers per acre.

At Sakrand in Sind, experiments on the reclamation of alkali land were continued. A part of reclaimed saline area was cropped continuously with cotton after cotton for seven seasons with no deleterious effects on yields. Similar results were obtained on continuous cropping with wheat on another portion of the reclaimed area. Experiments on the best means of maintaining permanency of reclamation were directed towards manuring and rotation. Three season's experiments including the one under review indicate that green manuring would be definitely helpful in maintaining a reclaimed area in

good condition. *Kalar* practically disappeared on such land. Among various crop rotations tested to prevent rise of salts, *guar*-wheat-cotton and *ragi*-wheat-cotton appeared to be two suitable rotations to minimise the return of salts.

In Mysore, it was again found that tobacco—Harrison Special—was extremely sensitive to even minute traces of alkali.

Reclamation of Eroded Land. At Parachinar in the North-West Frontier Province, an experiment was started to reclaim land that was badly eroded by floods. A wire crate bund was thrown across the torrent bed and the water was led out by a channel taken across the slope with a gradient of 1 in 300. Openings about two feet in width and one foot above bed level were made at intervals of fifty feet. The land on the down slope was laid out in skeleton terraces with banks one foot high. Weirs with boulder pitching were made in each plot to permit run-off of water as soon as the basin was filled. The land soon began to silt up. The cost of reclamation was stated to work out to rupees twenty per acre.

Soil Nitrogen. Laboratory studies at Poona on nitrogen fixation in rice soils indicated that rice soils carried an inoculum which was responsible for fixing large quantities of nitrogen in the presence of growing roots of rice plants. It was not clear if the inoculum was carried within the rice seed, but it appeared probable that it was carried on the surface of the rice seed.

At Nagpur in the Central Provinces, fluctuations in the organic nitrogen-content of black soils were observed. Under field conditions both loss and gain took place. Growing wheat annually for a number of years did not deteriorate the yielding power of soils; also growing a mixture of wheat and legumes every year did not show significant increase in the organic nitrogen of the soil.

At Dacca, loss of nitrogen as ammonia was noticed when fibrin and urea were applied to paddy soils. The *p*H of the soil had no effect. Added hydroxylamin also disappeared in all soils. With a limited supply of oxygen, no loss was noticed in the oxidation of ammonia and in the water-logged soils, photo

chemical decomposition was also absent. Nitrogen in the elementary form was lost only under anaerobic conditions from protein nitrogen. In regard to bacterial numbers, nitrifying organisms diminished with moisture saturation, but *azotobacter* persisted throughout wet, water-logged and desiccated periods. The evolution of carbon dioxide did not diminish on desiccation due presumably to a purely chemical decomposition.

At the Imperial Agricultural Research Institute, New Delhi, further studies employing different methods for the estimation of nitrates in soil did not indicate evidence of photo-nitrification. Sterilised solutions of sodium nitrite were not oxidised even after four months, while inoculation with nitrifying organisms resulted in the ready oxidation of nitrite.

At the same Institute work on nitrogen oxidation at low temperatures showed that in the course of atmospheric oxidation of elemental phosphorus, potassium or sugar, nitrogen was activated to combine with oxygen at low temperatures.

Soil Microbiology. *Nitrifying and non-nitrifying organisms.* At New Delhi and at Lyallpur in the Punjab, the influence of non-nitrifying organisms on nitrification was under investigation. Soluble carbohydrates interfered with nitrification until non-nitrifiers decomposed them. Soluble organic constituents of a normal soil and fermented manure did not, however, depress nitrification. Nitrifying organisms lived in symbiosis with non-nitrifying organisms and were thus able to overcome the toxic effect of soluble organic matter. Nitrification increased with increase in the number of non-nitrifiers introduced into the inoculum. The presence or absence of protozoa had no effect on nitrification.

Cellulose decomposition. In the course of investigations at the Imperial Agricultural Research Institute on enrichment cultures, made for the study of bacterial decomposition of cellulose, a new organism capable of growing and functioning only in association with other non-cellulose decomposing organisms was discovered. The morphological, cultural and bio-chemical characteristics of the new organism and of those

associated with it were studied. The products of metabolism and the quantitative dissolution of cellulose and nitrogen consumption as well as the nitrogen fixed by the organism in association with *azotobacter* was investigated.

Azotobacter. Further work at New Delhi, by serial transfers in broth confirmed the observation that *azotobacter* dissociated into several forms. These were isolated in pure cultures and none of these was capable of fixing nitrogen.

Manures and Fertilisers. *Manurial value of Molasses.* At Cawnpore, the manurial value of molasses to sugarcane and wheat was tested in pot and field cultures. At twelve tons to the acre and applied two months before planting, the results with molasses compared favourably with those of fertilisers. Applications at tillering time reduced yield and sucrose-content of cane. Improvement in the tonnage of ratoon cane was noticed. Molasses did not increase the yield of wheat, but there was appreciable residual effect from previous applications. The beneficial effect of molasses was more perceptible on poor than on rich soils. The application of molasses increased the nitrogen content and reduced the *p*H value of the soil.

At Shahjahanpur, the effect of applications at 90, 180 and 270 maunds per acre was studied. Total nitrogen accumulation was greatest with 270 maunds followed by 180 and 90 maund applications. Loss of nitrate occurred after a month after incorporation of molasses in the soil and continued in the molassed soil for a further period of three to four months. After sometime the non-molassed plots were found to accumulate more nitrate than the molassed plots.

It was found at Nagina that, if applied well in advance of transplanting the crop, molasses was found to be a good manure for paddy. Application just before transplanting scorched the crop badly.

In the Punjab, preliminary trials with molasses showed that the sugars disappeared within seventy-two hours after applica-

tion to the soil. An increase in the water-holding capacity of molassed soil was observed. At Jullundur, the effects of application of 180 and 270 maunds of molasses on sugarcane (Co 312) were compared with those of castor cake at ten maunds per acre. The yield of cane was decidedly in favour of molasses, but its price at 8 annas per maund was not economical.

At Coimbatore, molasses showed no significant residual effect on paddy.

Green manures. Experiments were carried out with sunn (*Crotalaria juncea*) at Shahjahanpur. Monthly analyses of soils were made after incorporating different portions of the plant. Nitrogen-content of the soil increased for two to three months after the incorporation and then gradually declined. The increase in the nitrogen-content was in diminishing order for whole plant, tops and roots and the yields of sugarcane were proportionate to the nitrogen-contents. The best time for incorporating the green manure in the soil, as shown by nitrogen estimations, was when the crop was fifty days old.

At Nagina, green manuring with whole plants did not show better than tops alone for paddy. Fibre extraction from the stalks, after using the tops as manure, did not pay the cost of extraction. Sunn ploughed when seven to nine weeks old resulted in better yield of paddy than when five weeks old crop was ploughed.

At Suri in Bengal, comparative experiments with cowpea, *dhaincha* (*Sesbania aculeata*) and sunn showed the relative merits in the order of cowpea, sunn and *dhaincha*. The differences in the yields of paddy were, however, small.

In the Punjab, green manures were very useful under *barani* conditions. Direct green manuring gave better results than when composted before application.

At Sakrand, berseem did not show any beneficial effect on the crop of cotton that followed. Also, previous green manuring did not show residual effects on cotton, while on wheat the results were inconclusive.

On *matasi* (loamy) soil in the Central Provinces, the application of nitrogen alone as sunn gave higher yields over control. Addition of phosphate further increased yield and also the phosphoric acid content of the crop, while with sunn alone the phosphate-content of grain was reduced.

Farmyard manure and composts. In Assam, applications of cowdung at one hundred maunds per acre showed no residual effect but at 200 and 300 maunds increasing residual effects were observed on Prasad Bhog paddy. In another set of experiments with *ahu* paddy, 100, 200 and 300 maunds applications gave progressive increase in yield from 10 to 39 per cent. in the year of application.

At Tocklai in Assam, experiments on tea with varying rates of cattle manure showed that the gain in tea-leaf from ten tons of cattle manure annually was about double that for five-ton applications annually. The effect of continuous manuring was cumulative being small in the early years and settling down in later years to nearly constant annual increases for the same dose annually. These gains with cattle manure were about half those obtained for a similar quantity of artificial nitrogen. A single big dressing of twenty tons per acre gave a marked effect for the four following years, but no further residual effect was observed for the two succeeding years.

At Bangalore, experiments on composting town refuse and other waste materials were conducted. Using ammonium sulphate, calcium cyanamide and sodium nitrate as starting materials, a recovery of 86 to 89 per cent of dry matter and almost entire conservation of nitrogen were reported when the ratios were 30 C : 1 N. At narrower ratios there was increasing loss of nitrogen. Experiments with night-soil on the applicability of hot fermentation method were carried out, and the comparative merits of concrete cisterns, trenches, pits and overground heaps were tried. It was observed that nitrogen was lost in the gaseous form unless suitable precautions were taken to maintain the 3 : 1 C/N ratio, by additions of refuse.

At Raipur in the Central Provinces, composts made of paddy straw and *karanji* (*Pongamia glabra*) leaves gave remarkably high yields of paddy on *matasi* soil.

In the North-West Frontier Province, *shora* bonemeal composts were prepared with raw bonemeal and crude saltpetre obtained locally. Ninety per cent of the phosphoric anhydride contained in the bonemeal was converted into the citric soluble form and when compared with Niciphos gave better cropping results. In conjunction with farmyard manure, *shora* bonemeal was very valuable to maize. When ploughed into the soil with green manure, the *shora* meal hastened the decomposition of the green stuff. Blood, mixed with thirty per cent of quick lime and dried, made a good manure with three per cent nitrogen and without offensive smell.

Inorganic Fertilisers. In Cochin, sulphate of ammonia was found better than sodium nitrate for paddy. For sugarcane, a mixture of ammonium sulphate and oil-cake giving a total of 150 lbs. of nitrogen was better than cake nitrogen alone.

In Mysore, experiments with *ragi*, groundnut, cotton and *jowar* showed that the application of artificial fertilisers was not economical for these crops. With sugarcane (H M 320), sulphate of ammonia was found useful and the variety could profitably utilise dressings of sulphate of ammonia up to 10 cwts. to the acre as against 7 cwts. previously reported.

At Dacca, it was previously shown by pot culture experiments that paddy could not grow without nitrogen. In the subsequent experiments, the need for phosphorus, potassium and magnesium was studied in pots in an artificial soil made up of 22 lbs. of sand and 11 lbs. of soil. It was observed that phosphate applications were more important than potassium or magnesium from the point of view of grain yields. Beyond a certain limit, phosphates showed a depressing effect. For Napier grass, the usefulness of lime and chemical fertilisers was indicated.

At Chinsura in Bengal, Niciphos, sulphate of ammonia *plus* superphosphate were good for paddy.

At Nagina in the United Provinces, only nitrogenous fertilisers showed, as in the previous years, any effect on the yield of rice. Phosphates had no effect either on yield or on maturity. Sunn gave as good yield as sulphate of ammonia and better yield than Niciphos. A mixture of sodium nitrate and sulphate of ammonia was no better fertiliser than either ammonium sulphate or sodium nitrate. Sulphate of ammonia in two or three doses gave better yield than a single dose.

At Padegaon, a consistent lowering in soil reaction was observed with sulphate of ammonia, farmyard manure and basic slag. Sodium nitrate, superphosphate and potassium chloride applications resulted in a rise in soil reaction. The effect of green manure, calcium cyanamide, bonemeal and sulphate of potash was not consistent. Irrigation resulted in the lowering of the *p*H value of the soil. Increasing doses of fertiliser nitrogen resulted in the stimulation of vegetative growth in sugarcane, but application of more irrigation water tended to diminish vegetative growth and hastened flowering and maturity. During the early period of growth, the predominating factor was the need for moisture in the soil. Investigations on optimum manurial requirements showed that the plant could take nitrogen up to 450 lbs. per acre. Studies by exudation methods showed that nitrogen exercised a predominating influence on the absorption of other mineral constituents, which were found in sufficient quantities in the soil to balance the demands from heavy applications of nitrogen.

In the Punjab, a number of fertiliser experiments were in progress in different parts of the country. Information so far available from the different farms would point to the direction that in the case of cotton but not with wheat, better results were obtained with sulphate of ammonia in two doses—one at sowing time and the other two months later—than when the entire dressing was given at one time. Less than 30 lbs. of artificial nitrogen would not increase crop-yields. The soils of

Rawalpindi responded to phosphate applications, which is generally not the case with the soils of the Punjab.

At Tocklai in Assam, application of nitrogen in rotation, two years as sulphate of ammonia and one year as calcium cyanamide, had the effect of maintaining for tea, the requisite soil acidity, as against increasing soil acidity with continuous applications of sulphate of ammonia. Response of tea to manuring varied in proportion to the increased dose of fertiliser. By about five years continuous manuring, the yearly increase in response ceased and the gain usually stabilised at a certain optimum increase. With 40 lbs. of nitrogen the increase over no-manure would be stable at about $3\frac{1}{2}$ to 4 maunds. In regard to the potato crop in Assam, Ammophos *plus* potassium sulphate gave a poorer yield than a combination of Niciphos *plus* potassium sulphate. The latter combination gave 13 per cent more yield than the former. Cowdung alone gave progressive increase in yield with increasing dose of the manure and at 400 maunds dose the yield of potato was 20 per cent more than Niciphos *plus* potash.

At Berhampore, the effects of ratios of nitrogen and P_2O_5 on paddy were studied. Starting with 25 lbs. of either constituent, the ratios of N : P as 1 : 0; 1 : 1; 1 : 2; 1 : 3 and 0 : 1 were employed. Sulphate of ammonia and superphosphate were the fertilisers tested. 25 lbs. nitrogen or a mixture of 25 lbs. of N. and P_2O_5 gave 23 to 30 per cent crop increase. Increasing ratios of phosphate did not appreciably influence the yield.

Combinations of organic manures and artificial fertilisers. At Hebbal, Naganahalli and Marthur, the use of fertilisers on basal dressings of green manure improved yields of paddy grain and straw.

At Risalewala in the Punjab, the effect of 140 lbs. of nitrogen, as farmyard manure, in equal doses of farmyard manure and sulphate of ammonia and in equal doses of farmyard manure and *toria* cake, were under comparison for three years. Combination of organic and inorganic nitrogen was the best

for the yield of *gur*. The yield with sulphate of ammonia combined with farmyard manure was equal to that from the combination of farmyard manure and *toria* cake.

At Padegaon, top dressings of a mixture of sulphate of ammonia and cake nitrogen in equal proportions and in increasing doses from 150 to 300 lbs. nitrogen to the acre indicated economic yields in spite of low prices of *gur*. As for phosphates super was better than Niciphos. On basal dressings of farmyard manure, or compost or cake, no difference was observed between 50 and 100 lbs. P_2O_5 applications on basal dressings of green manure; super was better than raw bonemeal both at 50 and 100 lbs. P_2O_5 doses.

At Berhampore, green manure, sulphate of ammonia, sodium nitrate and a mixture of sodium nitrate and sulphate of ammonia were compared on equivalent nitrogen basis with paddy as the test crop. The yield of paddy with sulphate of ammonia was equal to that with green manure. The yield with the mixture of nitrate and ammonium sulphate was nearly equal to that of green manure, while with sodium nitrate the yield was a little better than that for no manure. In another set of experiments sulphate of ammonia on a basal dressing of 2,000 lbs. of green leaf manure was far better than either leaf manure or sulphate of ammonia alone. The latter at 40 lbs. of nitrogen to the acre did not give proportionately higher yield than twenty pounds nitrogen as sulphate of ammonia.

At the same station, the comparative merits of bonemeal and superphosphate with green leaf manure and with and without sulphate of ammonia were tested. Super *plus* sulphate of ammonia *plus* leaf gave the highest yield and super was better than bonemeal. Super with or without sulphate of ammonia gave the same results. Addition of Ammophos with 4,000 lbs. of green leaf did increase yield, but it was not sufficient to cover the cost of fertiliser.

Effect of fertilisers and manures on crop quality. At Tocklai in Assam, the moisture-content of tea-leaf increased

with increase in the dose of complete inorganic fertiliser mixture. The increase, though significant, was slight, being less than one per cent in the leaf compared to unmanured plots. Phosphate had no significant effect on the moisture of the plucked leaf, but potash increased the moisture-content slightly but significantly.

At the same station was studied the influence, on the quality of tea, of phosphates with and without potash on a basal dressing of forty pounds of soluble nitrogen per acre. From the results of weekly manufactures of tea over rainy and autumn periods, it was shown that potash manuring resulted in a very slight but significant depreciation in the quality of tea as observed by Calcutta and London valuers. In regard to phosphate, the opinions of Calcutta and London valuers differ. According to the tests at Calcutta, phosphate manuring showed a slight increase in the value of tea, while London tests found no difference due to phosphate manuring. There was, however, an increase in the potash and phosphoric acid content of the teas made. Heavy phosphoric acid manuring depressed the potash-content of tea.

In Hyderabad (Deccan), large quantities of nitrogen delayed maturity of cane.

In Bihar, fertiliser nitrogen alone or in combination with phosphate showed no increase in the sugar-content of the juice, while nitrogen alone delayed maturity of cane by about a fortnight.

At Jullunder in the Punjab, gypsum at 1 and 1½ tons per acre had no effect on sucrose-content or purity or the ash-content of the juice of Co 213.

From Dharwar in the Bombay Presidency, the effect of farmyard manure on fibre characters of cotton was reported. Application of the manure to *jowar* crop showed an increase in the staple length and in the number of mature hairs in the succeeding cotton crop. Increasing applications of the manures over five tons to the acre showed a tendency towards decreased fibre-length and a reduction in ginning percentage.

2. Agricultural Meteorology

THE work on the " experimental " or " biological " aspects of agricultural meteorology and on the maintenance of co-operation with agricultural institutions and workers in India continued to form the major items in the programme of the section. Some investigations of a statistical nature were also completed during the period under review. Besides these, the section devoted attention to the subject of frost warnings and experiments on frost prevention. The issue of warnings for untimely or heavy rainfall to agricultural interests in the Bombay Presidency was also arranged for on an experimental basis.

EXPERIMENTAL OR BIOLOGICAL

The Central Agricultural Meteorological Observatory at Poona continued to be the main centre for experimental investigations. Some new instruments of local construction were under test and investigations on the micro-climates of different crops were continued.

The " invisible condensation " of water-vapour on the soil at Poona and the importance of this phenomenon as a secondary source of moisture in the soil were studied. There is a thin layer of dry soil at the surface which re-absorbs at night from the air all the moisture it evaporates by day and thereby sets a limit to the progressive loss of soil moisture. These investigations also indicate that some of the soils, *e.g.*, the black cotton soil, are very efficient absorbers of moisture from the atmosphere and may be used as cheap desiccating agents.

Some of the methods of influencing climatic environment for given practical purposes have also been studied. Experiments on the use of thin covers of substances like chalk, charcoal powder and soils from different parts of India show that surface-colour has a large influence on soil temperature, a white surface, for instance, having a large cooling effect on the soil-layers. Experiments on the use of heaters in vineyards to increase the air-temperature and thereby prevent frost, and on the effect of plant-covers in modifying the climate were also conducted.

The cooling at night of the air-layers near the ground was studied, as the subject is of great importance in connection with phenomena like cold waves, frost, etc. These investigations help one to appreciate the role played by water-vapour in the atmosphere. Experiments at different levels showed how objects exposed to the sky undergo a greater cooling by night than the air-layers themselves. The maximum effect of radiation occurs, at some distance above ground during clear weather.

Records of radiation from the sun and the sky were obtained from a solarigraph. The maximum value of the radiation falling on unit area of a horizontal surface at Poona is of the order of 780 gramme calories per day in April and May; the minimum value is roughly half the above value in July. The hourly and seasonal variation of the radiation income, and the dependence of the daily receipts of radiation on the duration and kind of cloudiness were studied.

The evaporation of water from free surfaces of water and from the soil was studied, evaporimeters of different makes being under comparison. A duplicate instrument of the Piche type and a soil evaporimeter of local design were exposed inside a standard screen in order to preserve the continuity of records during rainy weather. Evaporation data are very scanty in India. A scheme for installing Piche evaporimeters at a network of about forty observatories in India was drawn up and the instruments purchased by the Meteorological Department for this purpose were under test. The seasonal variation of soil moisture at different depths was studied. Moisture at the surface layers is closely associated with rainfall, whereas in the lower layers, the fluctuations are much less pronounced. It is found that the desiccation during the clear season is also confined to the surface layers. The method of estimating soil moisture by using a porous candle filled with water and connected to a special manometer was also under examination.

The scheme of experiments and observations at the Central Agricultural Meteorological Observatory is intended to provide,

ultimately, a full account of the various processes by which the energy received from the sun and the moisture received from rainfall are disposed of at the surface of the ground. Such work on the " thermal " and the " moisture " balance at the earth's surface is of fundamental interest in Agricultural Meteorology.

Statistical

The Statistical Branch of the Section was concerned with the analysis of (1) the data collected by the experimental section, (2) past meteorological statistics bearing on agricultural problems, (3) statistics of cotton outturn in relation to the meteorological and other related factors and (4) yield and meteorological data recorded at experimental farms. Under (1), special attention was paid to the study of the precision records of rice at Karjat. The " precision scheme " which has been tried in the case of few crops aims at providing full information regarding the local climate of a crop as well as its complete life-history during the growing period (*e.g.*, growth-rate, leafing, fruiting, incidence of pests, diseases, etc.) and finally the yield by using a suitable sampling technique. An experiment on the estimation of rice yields by sampling from cultivator's fields at Karjat was also performed in collaboration with the Crop Botanist to the Government of Bombay. Under (2), a number of problems were under investigation. The frequency of hail-storms in India was computed from past records. Maps of India showing the distribution of frequency during different months and during the year as a whole were prepared. The possibility of predicting, by a statistical method, the minimum temperature in different parts of India during clear weather from a knowledge of the maximum temperature and the pressure of water-vapour during the previous afternoon was investigated.

The frequency of phenomena like floods and droughts, heat waves, etc., was also under investigation, as also the inter-relationship between monthly rainfall figures recorded at different stations in the taluks of the Amraoti district.

It is hoped that precision observations of weather and crops like those being attempted at Poona and Karjat will lead to the collection of more complete data for future investigation.

Research Students

The voluntary research students of the Section undertook work on the border-land problems of radiation, convection, etc., and three of them earned the M.Sc. degree by their researches. The staff and students published about twenty original papers during the period under review. Some of the students are continuing work for their Ph.D. degree.

3. Plant-breeding and Genetics

Much of the information on plant-breeding has already been given under each crop in Chapter III dealing with ' Economic Work on Crops '. Only points of genetic and general scientific interest are reviewed briefly here.

Cotton. Important genetical investigations on cotton are carried on at the Institute of Plant Industry, Indore. A revised classification of cottons, both complete and in a form acceptable to taxonomists as well as to cotton-breeders, has now been published. Experiments have proved that a Chinese variety (*G. arboreum*) which has a red plant body and no petal spot, designated R^{LO}, is a new member of the R multiple allelomorphic series controlling anthocyanin pigment in the cotton plant. The inheritance studies of fuzziness in a cross between two Buri strains (*G. hirsutum*) gave indications of fuzzy seed being a double recessive. This will have to be confirmed by F_3 results. The genetic behaviour and inter-relationships of a number of lintless mutants have been studied. It would appear that at least four independent genes are involved in this character. In regard to the character of lintlessness, two genes are complimentary for hairiness and two for smoothness. A strong genetic association has been found to exist between one of the lintless genes and the leaf-shape gene. A new member of the leaf-shape allelomorphic series, intermediate between laciniated and narrow, was identified. Studies with

the interspecies cross with *G. anamolum*, where normal fertile hybrids have been obtained by back-crossing twice with the *arboreum* parent, are in progress with a view to obtain some economically useful types. A most important item of work of great value to plant-breeders is the study of the genetic variance of quantitative characters in three interspecies crosses in *G. arboreum* by a special type of replicated progeny row technique. The results that have been sent for publication have given interesting information on problems like heterosis, dominance and epistasy. Material from one of the above crosses, Cwn 520 × Bani, is likely to prove valuable in the scheme for improving Bengals which is being carried on at Bikaner. The replicated progeny row technique evolved at the Institute was also utilised to study the effect of selection on genetical variance which has resulted in a further improvement of lint-length by selection in strain Malvi 9.

In MADRAS, in connection with the work of improving Uppam cotton which had failed to respond to selection, a large number of valuable strains has been obtained by hybridisation. These are under district trials. Good opening and bad opening of bolls have proved to be a simple pair of Mendelian characters. The study of lint-colour in Upland cottons has shown a genetic association with lint-length, coloured lint being shorter in length than white lint. Similarly, lintlessness is found to be associated with hairlessness of leaves, later maturity and capacity to produce monopodial branches at the base.

In BOMBAY, the main problem in cotton breeding is to obtain resistance to wilt in addition to quality. The wilt-resistant strain BD8 is being exploited for this purpose by suitable crossing. Out of fifteen straight and back-crosses under study in Broach, two have given promising progenies. At Viramgam where the Wagad cottons are being studied, several selections, together with derivatives of the cross Wagad 8 × 1027 A L F, were under test at various stages. The newly introduced early Iran cottons should prove useful for hybridisation work.

In SIND, the main problem in cotton is breeding for resistance to jassid and red-leaf. None of the introduced types has shown much promise with the possible exception of A/12, —an African cotton which is still under trial. Hybridisation has been adopted to introduce the jassid-resistant character of Co 2 in Sind-American cottons. Simultaneously, the four fixed strains from 4 F-18 × Meade are under extensive trial.

In the CENTRAL PROVINCES AND BERAR, the work on Bani × *cernuum* was continued and a few useful selections were made. The chief feature of the year was the development to a field scale of four new strains, B 90, B 64, B 73 and B 61, bred from the wilt-resistant stock of *G. indicum*, which are fine linted and high yielders.

In the PUNJAB, another American strain, 47 F, has been developed. It promises to be superior in staple and ginning outturn to the established strain 43 F.

Wheat. In the PUNJAB, among the new crosses, one C 409 has shown its suitability for conditions in the North Punjab, where it outyielded 8 A by as much as 5 maunds per acre in some cases.

In SIND, besides the two hybrid strains mentioned in the last year's report, forty-eight line-cultures of another cross C Ph 47 × Pusa 114 were grown in the F_5 generation. Forty-four bred true.

In BOMBAY, a large number of hybrid cultures between Bansipalli and several others like Baxi, Pusa 4, Polish, and Punjab I were grown and further selections were made. The F_1 plants of the local wheat cross with Russian wheats immune for black stem rust were all sterile and over 1,000 back-cross pollinations also did not give any seed.

In the CENTRAL PROVINCES AND BERAR, breeding for resistance to rust is the most important problem. Some of the hybrids with Australian wheats are giving satisfactory results with regard to yield and rust-resistance. Direct crossing between *T. vulgare* and Khapli (*dicoccum*) (the rust-resistant wheat) having failed, two indirect methods were attempted,

viz., (1) crossing *vulgare* with *durum* and crossing the F_1 with *dicoccum* and (2) crossing *durum* and *dicoccum* first and crossing the F_1 with *vulgare*.

The Imperial Economic Botanist tested the F_2 population of eight crosses for rust-resistance and made selections for F_3 studies. Here also, as in the Central Provinces, the *vulgare* × Khapli cross proved sterile, but some other crosses such as *T. vavilovianum* × *T. vulgare*, *T. dicoccum* (Khapli) × *T. durum* and *T. dicoccum* × *T. persicum* gave vigorous hybrids.

Rice. In MADRAS, while the hybrid strains bred for *piricularia*-resistance and non-lodging straw have given satisfactory results in the districts, some of the homozygous families isolated from the X-rayed material have proved economically useful in small-scale tests on the breeding station. Extensive studies on the manifestation of hybrid vigour among various crosses with grains of different sizes have shown no relationship between the size of the embryo in the hybrid seed and the amount of heterosis expressed. The size of the hybrid grain (the endosperm) appears to have a definite influence on the hybrid vigour expression. In regard to pericarp colour, while dark red, light red and white have proved allelomorphic to each other, two light reds are complementary to each other, giving 9 : 7 of dark red to light red in the F_2 generation. Linkage studies have shown that the ripening black colour of the lemma and palea is independent of pericarp colour. A cross between a hard translucent grain with a soft opaque grain was intermediate in F_1 and gave a rough 1 : 2 : 1 ratio of translucent intermediate and opaque respectively in F_2, thus confirming the results obtained in Burma.

In the UNITED PROVINCES, inheritance studies have shown that awning in rice is controlled by three factors and that hairiness of the leaf-blade is dominant to non-hairiness. The inheritance of earliness or lateness in rice has been explained on a three factor basis. Studies on exsertion of the rice panicle have shown that the fully emerged condition is dominant over

the enclosed condition and the F_2 and F_3 segregations are explained with the help of three factors.

In SIND, the hybrid strain Silver Jubilee has been observed to be strongly resistant to the fungus *Helminthosporium oryzæ*.

In BOMBAY, the strain K × 501 has now been fixed and will be released for district trials. The cross P 6 × K-79 has given two families resistant to paddy moth. Further tests will be continued with them.

In BENGAL, anatomical studies are in progress on stems of different species of *oryza*, with a view to determine their relationship with habit. Cytological studies of the various purelines and crosses among them from a cytogenetic point of view are being continued. The number of chromosomes in the species *O. coarctata* has been noted to be 2 $n=44$ and this requires confirmation.

In ASSAM, the genetical studies in progress refer to the inheritance of leaf-striping, colour of lemma and palea, awning and stature of plant. Studies on deep water paddies would appear to indicate that flood resistance and capacity to yield are correlated inversely in many cases.

In BURMA, while genetical studies on sterility and abortive pollen have proved complicated, some useful results have been obtained on endosperm inheritance and grain shattering. One important observation made in Burma is that Mendelian characters such as size and shape of grain and colour of lemma and palea can be modified considerably according to the place in which the variety is grown.

Millets. In MADRAS, genetical work on a number of millets is being continued. In *jowar*, the short early type is a simple dominant over the tall type, but in *Setaria italica*, the tall was a simple dominant over short. While in the former increased height is brought about by a greater number of internodes, in the latter the increased height is due to greater length of the internodes. The heavy waxy bloom present on the stem, leaf-sheath, etc., in some varieties is a simple dominant over the sparsely bloomed condition. The incidence of dummy pollen in

large numbers in anthers is a simple dominant to its poor incidence. A case of dimorphism in pollen grains is recorded in *jowar*, the pollen characters being related to dimpled or normal grains. One interesting linkage relationship which has been established is between the purple leaf-sheath colour and juiciness of stalk. In *Eleusine coracana* Gaertn, the length of the glume is found to be controlled by three genes.

In BOMBAY, studies for resistance to the parasite, *striga*, have shown that the *jowar* variety Muddinandyal is highly resistant.

In SIND, crosses between grain *jowars* have reached the F_9 generation.

The South African variety of *bajra*, popularly known as Jamnagar Giant, has not given satisfactory results in Bombay and South India, but it has done well in Sind and parts of Rajputana. Since pure-line breeding in *bajra* is not feasible, a particular type of mass selection, known as compartment selection, developed at the Institute of Plant Industry, Indore, and adopted in some of the contributing States, has been found to give very satisfactory results.

Sugarcane. The most outstanding genetical work of the year is the production of a successful intergeneric cross between sugarcane and bamboo (*Bambusa arundinacea*) at the Imperial Sugarcane Breeding Station, Coimbatore. It is not possible to foresee the economic results that may follow from this very wide cross but there is no doubt that it is a unique achievement of great scientific importance and its further progress is keenly awaited by geneticists and plant-breeders alike. The cytogenetic studies of sugarcane have progressed and it has been possible to build up through suitable cross-breeding certain of the *S. spontaneum* types which occur in nature, thus providing experimental evidence regarding the origin of these forms. In selfed progenies of *spontaneum* a 1 : 15 ratio of erect to sprawling habit has been obtained. The IV glume present in *S. spontaneum* and the awn present in sorghum are inherited as

dominant characters in crosses with *S. officinarum* and *S. spontaneum* respectively.

Potato. A large number of crosses between Indian and imported varieties was made by the Imperial Economic Botanist during the year. Crosses using *S. demissum* as the female parent and *S. tuberosum* as the male parent were more successful than the reciprocals. Late blight appeared in an epidemic form in the year and this helped in gauging the relative resistance of varieties to it. It was found that while six of the 124 varieties of *S. tuberosum* from *S. America* showed a high degree of resistance, most of the varieties of *S. andigenum* were highly stem-resistant. In Madras, seventeen intervarietal and seventy-two interspecies crosses were made during the year.

Tobacco. Experiments conducted at Pusa on the leaf-curl disease by monthly sowings throughout the year indicated that, though the disease occurred in various degrees at all times, the incidence was heaviest in October. Grafting experiments with diseased *Hibiscus* and *Ageratum* (suspected to be alternate hosts of leaf-curl virus or viruses) gave negative results, except in the case of two grafts with *Ageratum* where leaf-curl was transmitted to previously healthy tobacco.

Oil-seeds. *Linseed.* At the Imperial Agricultural Research Institute two parents both having white petals gave on crossing an F_1 with blue petals and the F_2 frequencies showed that three factors were concerned in petal colour-inheritance. A number of rust-resistant cultures from crosses between local susceptible and foreign resistant varieties were grown both at Pusa and Karnal and further selections were made.

At Poona, 194 line cultures were under observation of which forty-eight showed a combination of better yield, higher oil-content and superior drying quality of the oil in them. Twenty-seven types received from North Ireland, Africa, Canada, United States of America and U. S. S. R. did not grow well under Poona conditions and their oil-content was also poor.

Selection work on the Malwa linseeds, which is in progress at the Institute of Plant Industry, Indore, has already given

two promising strains, one with white seed and the other with brown seed. Further breeding work for resistance to wilt, which is serious in Malwa, is in progress.

Brassica spp. All the Pusa types of Oleiferous *Brassicæ* were grown in Delhi and from the amount of seed-setting under bags in each type, an idea of the extent of self-sterility in the various species was obtained. Crosses were made during the year to investigate the problem of self-sterility in *B. campestris*. In the Punjab, a mass selection of *toria* (*B. napus* var. *dichotoma*) has been established and is being distributed to cultivators, its superiority over the local variety having proved satisfactory. Continuous mass selections in brown-seeded and pure-line breeding in yellow-seeded *sarson* (*B. campestris* var. *sarson*) have resulted in some useful breeding material. A high yielding and drought resistant *raya* (*B. juncea*) suitable for growing under *barani* conditions has been produced.

Groundnut. In Madras, 303 selections from F_3 and F_4 progenies of crosses to combine earliness, good yield and high oil-content were made during the year. The relative susceptibility of different varieties to *Rhizoctonia* wilt was determined. It was found that bunch varieties were, on the whole, more susceptible than the spreading varieties. Similarly, tests on periods of seed dormancy showed that only the seeds of those bunch varieties which had some spreading ' blood ' in them remained dormant as in the spreading varieties.

Castor. In Madras, 205 units were in-bred for maintaining purity. Twenty-seven selections from a cross between ' short compact-head, branching ' type and a ' long sparse-head, non-branching ' type were tried and all the selections matured in five months as against $8\frac{1}{2}$ months in the case of the control. Eight of these selections yielded as much as the control.

Selection work was continued and observations on various characters such as bloom, femaleness of the spike, spiny nature of fruit, etc., were made in varietal collections in Hyderabad.

Cocoanut. In Madras, where breeding work is carried on in this crop, 440 seedlings raised from nuts obtained by

hybridisation, selfing and natural pollination, were under study. Among the crosses between dwarf (early bearing, small but numerous nuts) and tall (late bearing and big nuts) types, the progenies of dwarf male and tall female appear most promising: they generally exhibit very good vigour. It was found that seed nuts from young trees germinate earlier than those from old trees. Morphological observations showed that heavy bearing trees retained their leaves longer and that for selection of seedlings from the nursery a good girth at the collar region was a useful criterion.

Other crops. *Gram* (*Cicer arietinum* L.). The results of the inheritance studies at the Imperial Agricultural Research Institute were published during the year. The inheritance of seed-coat colour is explained with the help of five factors. Two groups are recognised. In one, the seeds are yellow to dark red, irregular shaped and with a granulated surface: in the other, they are bluish brown, round and smooth. The flower of the first group is pink and of the second blue. The mutations obtained for narrow leaves and single leaves were maintained.

In Madras, the occurrence of mutations was found to be a common feature and varieties that threw mutants originally gave the same mutations with almost the same frequency.

In the Punjab, while most of the local varieties proved susceptible to gram blight, three French types introduced from America were found to be extremely resistant.

Pigeon-pea (*Cajanus indicus* Spreng). The results of genetical studies reported during the year from the Pusa Institute refer to the inheritance of such morphological characters as flower colour, habit and stature of the plant, nature of inflorescence and colour of seed-coat. Though seed-coat colour inheritance is explained on a monofactorial basis as with other characters, it has been stated that a more complicated system of inheritance is suspected. Studies on wilt-resistance showed that the inheritance might be explained in a 9 : 7 or 27 : 37 ratio; resistance being dominant. The inheritance of resistance was not linked with any of the morphological characters

mentioned above. In Madras, it is stated that three factors are involved in the inheritance of seed-coat colour.

Genetical studies on Lablab (*Dolichos lablab* Roxb. & L.) in Madras have led to the identification of sixteen genotypes involving four seed-coat colours,—black, chocolate, khaki and buff—together with grades of pigmentation in internode, leaf axil, calyx, petals, etc.

Miscellaneous. At Pusa, an interspecies cross in chilli, *C. annum* × *C. frutescens*, was studied for the inheritance of flower-colour, colour of fruit, fruit position and number of pedicels. At the same place, the study of a virescent mutant in barley has shown that while the mutant can be recognised when the seed is sown at the normal season, the virescent condition does not appear when the seed is sown in summer. In Bihar, a simple and effective method of selfing sunn-hemp has been evolved and this should facilitate the establishment of pure-lines.

4. Plant Physiology

Cotton. The physiology scheme in Sind which had continued for ten years was closed down. Definite and useful information on the optimum time of sowing, the time at which the first irrigation should be given, the optimum intervals between irrigations, etc., have been obtained. It has been found that a declinary system of irrigation as the crop progresses is more beneficial than a fixed interval of, say, twenty days between two irrigations. With regard to manuring, ammonium sulphate applied at two maunds per acre at the time of boll-formation on a basal dressing of a bulky organic manure has given the most satisfactory results. Studies on incidence of ' red leaf ', a menace to the American cottons in Sind, have led to the recognition of two distinct types of ' red leaf ': one associated with jassid attack and the other due to a soil deficiency. The usual detailed meteorological observations were maintained for correlation with the development of the cotton plant.

In the important physiological investigations on the periodic partial failures of American cotton in the Punjab which have been in progress for two years, it was concluded that the bacteria mentioned in the last report were not related to the failures. Certain abnormalities have been observed in the plant. These are disintegrated chloroplasts in the leaves, the accumulation of starch in the roots and leaves and the formation of tannin and tannin derivatives in the roots, stems and the leaves. The sequence in which these abnormalities occur and the factors responsible for setting up the chain have not yet been discovered. The year's work has led to an inference that the primary cause of the trouble might be located in the soil itself; in fact, the application of sodium chloride and sodium carbonate did produce the characteristic symptoms associated with failure even in good soils. In view of the great importance of the problem, the services of Dr. T. G. Mason, F.R.S., were obtained on loan from the Empire Cotton Growing Association so that he might study on the spot the results which have been obtained and advise as to the lines on which further research should be concentrated.

In the Madras Pempheres and Physiological schemes, the relationship between the water-soluble polysaccharide in the stem and the readiness of the plant to produce gum was further examined. It was found that not only does the amount of total polysaccharide vary widely according to the season but the make-up of the polysaccharides is also different in stems and leaves. It would, therefore, not be safe to apply the criterion for choosing resistant types from a segregating population by estimating the polysaccharides in the easily removable parts of the plant only, such as leaf and petiole. The examination of F_2 and F_3 generations and back crosses between Co2 and gum-forming South American types has shown that the gum-forming character is heritable, but unfortunately most of the resistant segregates lack the desirable features of Co2. Investigations into the causes of failure of Cambodia cotton (*G. hirsutum*) in black soils have revealed that the trouble is due to mal-adjustment in the

respiration of the roots due to a greater accumulation of hexose sugars in them.

Very interesting information of an ecological nature has been obtained by the crop census work carried out by the Indore Institute on the cottons of Malwa and Nimar. The local cotton as grown by the cultivators is a mixture of both *desi* (*arboreum*) and Upland (*hirsutum*) cotton in the proportion of 40 and 60 per cent respectively in Malwa and 80 and 20 in Nimar. In spite of the fact that when the Upland cotton is grown pure yields are poor, it is found to thrive in the mixture and to maintain its proportion from year to year. Properly designed field experiments are being carried out to determine if this behaviour was due to competition effects between the two types. The *desi* component of the mixture itself consists of the four genotypes, broad leaf yellow flower, broad leaf white flower, narrow leaf yellow flower and narrow leaf white flower. The proportion of these four genotypes is different in Malwa and Nimar and remains constant from year to year. Physiological experiments are under way to discover the main factors responsible for the observed differences in the survival value of these four genotypes.

Sugarcane. At Padegaon, studies on water-requirements of the cane crop, including investigations on the influence of the sub-soil water-table and of the combination of water and manure on cane-growth, have shown a clear differentiation between the periods of response of the crop to water and to manure. Scientific investigation of the mechanism of absorption of mineral nutrients by the plant has been continued. Nitrogen has been shown to have a predominant influence in the absorption of other mineral nutrients. Studies on germination have demonstrated the existence of two distinct currents of food material one directed to the root zone of the internode immediately above the node and the other from the lower internode to the bud.

It has been found in Bihar that the defect in germination due to the slow rate of inversion in the planted sett can be

remedied by soaking the sett in a saturated solution of either warm water (85°-90° F) or lime for forty-eight hours. One interesting observation, that manuring and earthing up between irrigation intervals actually retarded growth, would appear to indicate that this operation must be done judiciously. With regard to water-requirements and total dry matter produced, varietal differences are apparent and Co 331 is found to be the most economical. The degree of transpiring surface has not shown any relationship to the relative water-requirements of varieties.

Experiments to determine the interrelationship of nitrogenous manuring, water duty and date of planting were continued in the United Provinces. More plants are found to survive in treatments where the water duty is more: possibly this result is due to the water checking white ant attack. Nitrogen is found to be beneficial at all levels of watering and at all sowing dates but it is most effective in the early planted crop. Heavy water duty is found to inhibit tillering. Leaf area has been found to decline considerably with delay in sowing, irrespective of nitrogen and water requirements. Experiments with growing canes in culture solutions have shown that the absence of nitrogen results in the lowest yield, while the absence of magnesium and phosphorus significantly depresses the yield. Leaf areas are greatly reduced under nitrogen and phosphoric acid deficiencies.

Germination studies on sugarcane varieties over a series of years at the Imperial Sugarcane Breeding Station, Coimbatore have shown that observed differences depend upon the inherent capacity of the female parent. With regard to actual seeds, those from sessile are found to give better germination than those from pedicelled spikelets.

In the Punjab, studies of the freezing temperature and *p*H of the leaf-cell sap of various resistant and non-resistant varieties to frost have not revealed any definite differences.

Investigations on the chemistry of sugar formation with different times of planting, carried out in Madras, have shown that the age of the crop is in itself no criterion of its maturity.

The sequence of the seasons during which its life-cycle is spent has more effect on its growth, development and ripening than age. Concentration of juice tends towards a minimum when the vegetative growth is towards a maximum. This concentration appears to improve towards a maximum by rapid strides when growth tends to stop. The crop has to produce a certain amount of vegetative growth to be able to take full advantage of the favourable conditions of the season and that this minimum is obtained only when the crop is planted at a particular time of the year—January to June for Madras conditions.

Rice. Studies at Dacca in regard to the absorption of nutrients at different stages of the plant-growth have shown that if the growth of the plant is not vigorous during the early and active vegetative period, as is usually the case in an unmanured and poor soil, the plant may absorb about 25-50 per cent of its total intake of nutrients after flowering. On the other hand, if the vegetative period is vigorous, as in a rich soil, the plant may absorb only 5 to 10 per cent of its nutrient requirement after flowering. There are indications of losses of nutrients especially nitrogen and iron from the plant in the last two weeks of its growth. Evidence has also been produced in support of a possible downward movement of nutrients, potash, nitrogen and iron in the rice plant during the maturing period.

In the " quality " investigations conducted at Coimbatore, an indication has been obtained that the pericarp thickness is comparatively greater in coloured and coarse rices and that it can be increased by applying fertilisers to the soil, bulky organic manures, like green leaf, producing maximum thickness.

Physiological investigations under Dry Farming Schemes. In Madras, the moisture-content of the soil for optimum germination of sorghum and *setaria* was found to be 20-25 per cent. Moisture below 15 per cent gave no germination and above 25 per cent retarded germination. In the soil-moisture studies,

one important observation that has been made on experimental evidence is that intercultivation or mulching is only incidental to the operation of destroying weeds and by itself does not help moisture conservation.

In Bombay, the addition of farmyard manure does not affect the optimum soil-moisture condition for germination of seed *jowar*. The wilting coefficient depends on the nature of the soil; it is higher for medium deep soil and lower for light shallow soil. Experiments on the transpiration of water have confirmed the results of the last year, in that there is no difference between *jowars* with loose and compact types of head and that the addition of organic and inorganic manures economises the use of water.

In the Punjab, the minimum moisture-content of the soil necessary for germination of *jowar* and *bajra* is six per cent. A comparison between *jowar* and *bajra* grown in medium loam soils has indicated that while *bajra* benefits by soil drought, *jowar* is affected adversely by it. A lighter soil is found to lower the water-requirement for both the crops.

Tea. Physiological work carried on at the Tocklai Experiment Station has suggested that apart from " tip " the hairiness of different *Jats* is in some way a measure of " quality " and/or " flavour ". Investigations are in progress to analyse the seasonal variation in the amount of hair into the two components of climatic change and periodic change inherent in the bush and to determine their relation to cultural operations. It is considered that any importance which hairiness may have in relation to " quality " tea is as a measure of Xeromorphism and the hypothesis has been advanced that better teas are always made from more Xeromorphic leaf. Studies on flushing the tea bush have shown that the number of times which a shoot will branch under the influence of plucking (taking an average for all the shoots which arise after pruning the bush) is not numerically greater than the possible number of flushes which a shoot could make under natural conditions in a similar

period of time. This should mean that the natural flush periods of the plant set a limit to the number of times which a shoot can branch. Work has also been started on selection of bushes for seed production on the basis of manufactured leaf from individual bushes.

Other Physiological Investigations. At the Benares Hindu University, experiments have been made on the water-requirements of over one hundred species and varieties of plants. A marked correlation has been found to exist between high yield of varieties and their water-requirement. Vegetable crops need generally a higher moisture-content in the soil than cereals. Marked variations in water-requirements as a result of variations in mechanical conditions of the soil and presence of fertilisers have been recorded. Studies on respiratory phenomena have established the fact that longevity is proportional to the initial respiratory energy with which the young organism starts. It is possible to select varieties for early and late maturing on the basis of simple and limited physiological tests on velocities of metabolism. Chlorine, when supplied in certain concentrations and in the form of different chlorides, has been found to stimulate growth. Tropical plants have been shown to make a characteristically different assimilatory response from that of plants of temperate regions. Other researches carried on here refer to storage experiments on potato and mangoes.

The effect of minute doses of X-rays and ultra-violet rays on seeds and crops has also been investigated at Benares. In the case of gram, wheat and tobacco, ultra-violet exposures of fifteen minutes given first to seeds and later periodically to the crop greatly benefited germination and growth. Similar observations have been recorded with X-ray treatment given to the tobacco plant. Similarly, maize seed exposed to ultra-violet rays at a distance of 18 inches for three seconds has given satisfactory results in the North-West Frontier Province.

In connection with the causes of infertility of Kala Bagh estate soils in the Punjab, Prof. Bhatnagar has studied the

effect of sulphurated hydrogen gas on plant growth : the crop under experiment was maize. A comparison of the effect of this gas on plant-growth during winter months with that during summer months has shown that mineral water containing the gas has definitely a retarding influence in the former but no difference is noted in the latter. This is explained as due to the fact that during summer months the concentration of the gas in the water is lower than in winter months owing to the difference in temperature and rate of evaporation.

Dr. Boshi Sen, with the help of funds provided by the Imperial Council of Agricultural Research, is studying the living protoplasm—the cytoplasm and the plasma-membrane—of the root hairs of *Azolla pinnata*. The effect of different cations on the living protoplasm was first studied by micro-injection but as the method proved unsatisfactory, a new technique—the " Increased Permeability Method "—of introducing solutes in living cells has been perfected. He has also carried out successfully some vernalising experiments with mustard (*Brassica juncea*).

5. Plant Diseases

Soil-borne diseases and root-diseases. Considerable advances have been made in the study of cotton root-rot. In the PUNJAB, it had already been shown that there is a marked falling off in infection with root-rot when cotton is sown later than the middle of June. It has now been shown that this effect of sowing date holds good also for BARODA, where it has also been found that the maximum activity of the fungus occurs at a depth of 6-12 in. from the surface of the soil. The latter fact is being taken into account in breeding resistant varieties of cotton, for it has been shown that the resistant varieties are those producing least lateral roots in these heavily infected sections of the soil. In the Punjab, it is found that *Rhizoctonia solani* produces sclerotia best in rich deep media of an almost neutral reaction, but *R. bataticola* can produce them in very

acid media. The fungi were able to use nitrogen from various sources for their growth.

The wilt disease of sunn-hemp has been studied in BOMBAY and the fungus is regarded as a strain of *Fusarium vasinfectum* Atk. The particular strain studied can readily attack three species of *Crotalaria* but apparently not *rahar* and cotton. The fungus is seed-borne.

Foot-rot and wilt of *pan* (*Piper betle*) have been studied in ASSAM, CENTRAL PROVINCES, BENGAL and elsewhere. In the Surma Valley in Assam, the disease is reputed to be due to *Rhizoctonia;* in BENGAL, to *Phytophthora* also. Control measures involving chemical treatments of the soil have met with varying success. Further progress in controlling this disease cannot be obtained without a more accurate knowledge of what is the causal organism in various districts.

Work on root-rot of coconut is still going on in Southern India, but so far the cause of the disease has not been found.

The effect of fertilizers on *Fusarium* foot-rot of rice has been investigated in MADRAS. All the types of fertilizers used increased the disease, but it was very much more marked in the case of nitrogenous fertilizers than with potash or phosphate. It was also found that the fungus when grown on a soil extract medium was stimulated by addition of nitrogenous salts such as ammonium sulphate and asparagin, and it was concluded that increased disease incidence in the field was due to better growth of the fungus in a nitrogen yielding medium. More experiments are necessary to confirm this.

It has been found that the greatest spread of the root eelworm disease of coffee occurs in the wet season. Experiments have been started to starve out the eelworms by removing coffee plants from infected patches and keeping the soil bare during the wet season.

Unfortunately the study of root diseases, particularly those caused by species of *Fusarium*, is complicated by the fact that several fungi may be involved in producing disease in a single

plant. A straightening out of these problems is very necessary, and unfortunately will be a long process.

Foliage diseases. The method of controlling gram blight (*Mycosphærella rabei*) in the PUNJAB by clearing up all debris and sowing blight-free seed has been found impracticable owing to the impossibility of making the cultivator do the work. Resistant varieties are therefore being sought from other parts of India and abroad, and there seem to be some possibilities in certain varieties obtained from France.

A number of diseases of tea have been found in the Kangra Valley, Punjab, the most important of these being Gray Blight (*Pestalozia theœ*) and Brown Blight (*Colletotrichum camelliœ*).

Fruit spoilage. A beginning has been made in BALUCHISTAN and the UNITED PROVINCES to survey fruit rotting organisms.

In BURMA, some very interesting experiments have been done on storage of fruits at low temperatures and after dipping in various chemicals and wrapping in iodized paper. One rather striking point is that dipping mangosteens in formalin greatly reduced rotting when the fruits were stored at high temperatures (81-89° F.) but actually increased the rotting at low temperatures (35-50° F.). The impression is gained that the chemicals used as dips or wraps for mangosteens, mangoes, oranges and sweet-limes were not very promising and that much more hopeful results may be expected from cold storage.

Breeding resistant varieties of crops. Under the Rust Research Scheme of the Imperial Council of Agricultural Research, it has been found that two more indigenous species of barley, in addition to *Berberis lycium*, have successfully been inoculated recently. It is presumed that renewed efforts will be made to find infection in nature.

Twenty-three wheat varieties and one F_2 cross have been tested against various Indian physiologic races of Black Rust for seedling resistance, as well as certain F_2 crosses for seedling resistance against Brown and Yellow Rust. In addition,

twenty-four indigenous and foreign varieties have been tested for adult resistance against mixtures of the six known Indian forms, but results of these tests have not yet been published.

Tests with twenty-two Coimbatore varieties of sugarcane indicated some differences in susceptibility to mosaic but nothing approaching immunity. Using the same varieties, some resistance to red-rot (*Colletotrichum falcatum*) and wilt (*Cephalosporium sacchari*) was indicated.

The search for varieties of cotton resistant to wilt in BOMBAY is being continued. Certain promising selections have been made. There has been a slight set-back as a result of the decision of the Indian Central Cotton Committee to replace as far as possible the short-staple varieties with medium or long staple. Some crosses of the Goghari type were consequently rejected, while others were back-crossed with the wilt-resistant good-spinning strain BD 8.

A heavy epidemic of late-blight of potatoes (*Phytophthora infestans*) occurred in Simla in 1936 and gave an opportunity for studying the disease reaction of a number of commonly cultivated varieties from Europe, South America and India. In addition many tuber-forming species of *Solanum* from abroad were found immune and others highly resistant. There appears to be material available for evolving types with the desired characteristics which are resistant to blight.

Fungicides. The bunt disease of wheat caused by *Tilletia indica*, which is partly soil-borne, was reduced by dusting seeds with Ceresan, Agrosan, Hortosan, Germisan and sulphur dust, but complete control was not obtained. Possibilities of using sulphur on a considerable scale as a seed-dressing in India might be investigated, since it is a cheap and safe chemical to use. Solar heat also greatly reduced infection, and as the method is also being recommended for loose smut, this is a further point in its favour.

Hydrogen cyanide gas was found very effective in killing sclerotia of the cotton root-rot fungus to a depth of eighteen

inches in the soil. The possibility of using hydrogen cyanide and other chemicals for controlling root diseases of valuable crops might open up an interesting line of work.

Evidence has been brought forward by the Indian Tea Planters' Association that black rot disease does not spread rapidly from tree to tree. Spraying infected trees during the cold season with Burgundy mixture or lime-sulphur solution was ineffective, but their use during the rainy season produced some control. Burgundy mixture was more permanent than lime-sulphur, and 1 per cent solution was almost as good as 4 per cent. Permanent recovery is possible with repeated sprayings. No control was afforded by removing prunings of infected bushes.

The callousing of wounds on tea due to pruning was found to be stimulated by Bitumen mixtures, whereas Rosin-Burgundy mixture was ineffective and coal-tar reduced callous formation.

In controlling leaf-disease of coffee, it was found that it is more important to try to check the first stages of disease spread after blossom showers than to cover the maximum leaf area with the spray.

Nutritional disorders. In the Punjab, a disease of cotton believed to be physiologic in origin, typified by early reddening and shedding of the leaves, premature opening and in extreme cases dwarfing of the plants, is being studied. Many possible explanations are being investigated, and the opinion seems to be hardening that the trouble is due to unbalanced nutrition and that in sandy soils at least it may be alleviated by addition of nitrogen and phosphorus together. The disease is found in soils with alkaline sub-soil, soils with compact and impermeable soil-layers and sandy soils.

Virus diseases. Evidence shows that the thick variety of sugarcane Surkha Saharanpuri shows greater reduction in yield due to mosaic than the thin cane varieties, 16 per cent reduction being reported. Slight secondary infection was also

found. As a result of thermal death-point studies, it has been found that mosaic can be divided into at least three virus strains of thermal death-points 40-50° C., 50-60° C. and 60-70° C. In the last two of these no " recovery " of canes is found, whereas in the first at least 40-50 per cent of setts from infected canes produce healthy plants. The lower the temperature of storage of juice, the greater the length of time the virus remains viable, and there is some indication that juice from leaves stored at low temperatures from 48-96 hours is actually more active than juice from fresh leaves. Lastly, it has been shown that addition of healthy juice to infected juice inhibits the active principle of the virus, unless the healthy juice is passed through filter paper until an amber liquid results. This inhibitory action is most interesting and if followed up might throw much light on the nature of resistance to mosaic and on frequent failure to produce the disease on known susceptible varieties.

Leaf-curl of tobacco appears to be a serious menace to tobacco culture in Northern India. There are at least five types of leaf-curl, named A, B, C, D and X. The first four are produced by single viruses, the last named by a mixture of two or more. A number of symptoms are common to all the five types, but all the five are readily distinguished by certain characteristics. All are transmissible by grafting but not by juice or by seed.

With regard to control, not a great deal is yet known, but it has been shown that the disease is lessened by removing infected plants. Removal of alternate hosts is also an obvious step, but it is not yet known how many of these there are in India. While the breeding of resistant varieties is a desirable end to attain, there is so far little indication of resistance in the varieties grown at Pusa.

General. A supplement of Butler and Bisby's " Fungi of India ", bringing the total number recorded in India to 2,806 species, has recently been issued.

A fungal culture collection has been started at the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE and the number of named cultures available for distribution is now 175.

6. Entomology—Insect Pests

(a) *Locusts*

I. LOCUST SURVEY WORK

WORK on the distributional survey of the habitats of the Desert Locust in Sind, Baluchistan and Rajputana and on the ecological observations of its natural habitat in typical centres was continued on the same lines as in the previous year.

BREEDING OF THE DESERT LOCUST IN ITS NATURAL HABITATS.

Winter-spring breeding—1935-36. As the rainfall in the Mekran areas during the winter-spring period of 1935-36 was below normal, only light breeding was observable there both along the coast and in the interior. Green hoppers were found in small numbers between March and May and the earliest adults of the new generation were noted by the middle of April.

Summer breeding—1936. There was practically no breeding in Baluchistan during the summer months, except in the Lasbela area, where comparatively light falls of rain were followed by moderate breeding. In the Sind-Rajputana areas, on the other hand, monsoon rains were heavier and led to a considerable breeding. By June, fair numbers of solitary-phase locusts, presumably derived from the areas of winter-rainfall in Baluchistan, were found making their appearance in various parts of the desert, and hoppers were noticeable during July-August in such areas as had received good rainfall. The first adults of the new generation appeared by the middle of August.

During August 1936, very heavy rainfall, amounting to a total fall of about fifteen inches within a week, was recorded in parts of Bikaner and east Jaisalmer and was followed by the appearance of concentrations of solitary locusts in these areas,

leading to fairly heavy breeding. As large numbers of hoppers were noticeable even by the end of November, it was obvious that the breeding had resulted in the production of a second generation of fairly high magnitude during the monsoon period.

Distribution of locusts during autumn and winter of 1936. In the southern areas of the desert, such as the Thar area of Sind, the Mallani area of Marwar, and the southern parts of Jaisalmer, breeding was restricted to the first generation, and the locusts thus produced were found disappearing from these areas by the middle of September. These areas were fully clear of locusts by the end of December, and no locusts were to be seen there till June 1937, when migration from the western areas set in. There was thus no over-wintering of locusts in these areas in the year under report.

At about the same time, *viz.*, by September-October, 1936, the locust population in the Lasbela and Mekran areas began to increase considerably by the addition of individuals of a recently developed generation, and this circumstance may be considered as presumptive evidence of an immigration of locusts from the desert areas.

In the east Jaisalmer and west Bikaner areas also, there were evidences of an emigration of the early brood of locusts up to the middle of October, but the adults of the second generation appearing during November were found passing the winter in the areas in which they had been produced, and while over-wintering, their numbers suffered considerable diminution due to frost.

Spring breeding—1937. Along the Mekran coast, there was very little winter rainfall, so that breeding was entirely absent all along the coast from Hingol to Jiwani. On the other hand, normal rainfall was registered in the interior of Mekran and in Upper Baluchistan, and in parts of Lasbela State. Consequently, light breeding was observable in the interior valleys of Mekran and Upper Baluchistan. In the Lasbela area, an outbreak centre developed near Sheh Lakhra, presumably as

a result of locusts which had migrated from the coast concentrating in patches of *jowar* cultivation on the banks of the Porali river. In the Kachhi area, fairly heavy breeding was noticed among the natural vegetation springing up after rainfall in scattered patches in natural depressions. Hoppers were noticeable in this area in varying numbers from April to July, 1937. Similar breeding was also noted in the Bolan and Spezand valleys in the interior.

In the Rajputana area, fairly heavy spring rainfall occurred in Jaisalmer and Bikaner in February, which was followed by light breeding noticed during April and May in parts of these areas, as a result of the oviposition of the locusts over-wintering in these parts. With the advent of dry hot weather in March, however, adult locusts totally disappeared from these areas, and it is presumed that they had reached the Kachhi and Baluchistan areas in March and had started the hopper infestation, mentioned above, found during May-June 1937.

Breeding of Locusta migratoria—*ph.* solitaria *in Spring, 1937.* In previous years *Locusta migratoria* had usually been noted by the Locust Survey Staff, in small numbers along with the individuals of the Desert Locust, in various parts of Sind, Rajputana and Baluchistan. In the year 1937, however, considerable numbers of hoppers and adults of the Migratory Locust were noted in May and June in the Kachhi area, as also a fairly high concentration of both adults and hoppers, in June, at Kirta in the Bolan valley of Baluchistan. A somewhat similar breeding was reported likewise from the Kohlu valley of Sibi district in June 1937.

This event is noteworthy since it was apparently connected with the heavy breeding of this locust noticed later on in the year (July-August) in the eastern parts of Bikaner and also with reports of its hoppers on millet crops in September-October, 1937 in parts of Sirohi, Palanpur, Mehsana and Idar areas.

Experimental Work

Experiments regarding the influence of different food-plants in quickening the sex-maturity of adult locusts were continued, as also in regard to their effect on the duration of the hopper period. Experimental observations were made also on the preferences exhibited by the adults and hoppers in regard to different food plants.

A biometrical study was made of the collections of locusts from different areas under observation, in order to note changes, if any, in the phase characters of the locust populations in the course of the year. The nature of correlation between eye-stripes, larval moults and antennal segments was also under study.

Work on Locust bionomics done at Lyallpur

Environmental factors, especially temperature, during the hopper stage, greatly influence the reproductive phenomena of the locust in its adult stage, the size and the degree of sexual maturity of the gonads at the time when the locust acquires wings varying in inverse proportion to the temperature at which the locust has passed its hopper stage.

Hoppers of the Desert Locust show a definite preference for higher humidities in the middle of each larval stage, particularly if they are starving. For a certain period before and after moulting, they were not found to react in this manner. The percentage of body moisture in the locust decreases with the age of the insect. The younger stages of the locust can withstand starvation in drier conditions appreciably longer than the adults.

(b) *Other Insect Pests*

Sugarcane. In the laboratory of the Imperial Entomologist at New Delhi, the data collected on the incidence of borers and on the comparative susceptibility of five varieties of cane

at Pusa during 1935-36 were examined statistically. The following are the conclusions of this one year investigation :—

At PUSA, the borer attack starts in April and as the season advances, all the three borers, *viz.*, top, stem and root, become active, causing the largest number of dead-hearts during June and July. Their activity, however, decreases in the rainy season but increases again in autumn when the top-borer causes very serious damage. Taking all the borers into consideration, Co 313 and Co 299 seem to be most resistant, Co 331 moderately resistant, Co 213 and Co 210 least resistant. The relative amount of actual loss caused by various borers to mature cane of Co 331 in 1935 was also estimated. It was found that the incidence of various borers being equal, the stem-borer actually did most damage in reducing the weight and sucrose-content of cane, the top-borer came next in importance and the root-borer caused no damage to mature cane.

Work under the sugarcane pests scheme financed by the Imperial Council of Agricultural Research was started at New Delhi in the summer of 1936, and observations on various pests and their parasites at Delhi, Karnal, Pusa and Coimbatore were made. The root-borer, *Emmalocera depresella* Swinh., was found to be the commonest borer in young sugarcane plants at Delhi. New parasites, bred from material collected at various places, included *Melcha ornatipennis* Cam., and *Elasmus zehntneri* Ferr., on larvæ and pupæ of *Scirpophaga* respectively, and *Azotus delhiensis* Lal, on nymphs of *Aleurolobus barodensis* Mask.

In the PUNJAB, the susceptibility of various improved Coimbatore varieties to top-borer and *pyrilla* was under examination. Liberally irrigated fields showed greater top-borer attack than those with restricted irrigation. Control measures tried included destruction of egg masses of *pyrilla* towards the end of April and early May and hand-picking of borer moths and their eggs and removal of affected shoots in March and May.

In the UNITED PROVINCES, the incidence of borers, *pyrilla* and the cane white-fly on different varieties of cane in reference to certain climatic and cultural factors was studied at Muzaffarnagar. Rains in May and June reduced stem-borer (*Argyria sticticraspis*) infestation from 20-30 per cent to 10 per cent and also hindered the multiplication of the white-fly and *pyrilla*. Among early varieties Co S 60 and Co S 98 and among late varieties Co 312 and Co 393 showed significantly greater resistance to stem-borer attack than other varieties. Of the varieties so far received from Shahjahanpur or Coimbatore, Co 411 was found to be the most resistant to top-borer attack, Co 385 coming next. No correlation was found to exist between the percentage of infestation and intensity of borer attack, nor was the percentage of infestation always proportional to the losses at harvest. The varieties Co 114 and Co 421 showed less infestation than others and the least loss at the end.

Experiments showed that very late sowings are harmful from entomological as well as agronomic points of view due to greater borer trouble, poor germination, bad growth and less yield.

Late in the season stripping and removal of dry leaves was found useful in reducing *pyrilla* attack and early earthing protected the tender stalks from the attack of stem-borer during the hot weather. Burning and removal of cane trash did not appear to be followed by any variation in attack by different pests though stem-borer infestation seemed to increase in trash-burned plots. The removal of new shoots from cane stubble and from late standing canes during March and April was found useful as these shoots are mainly responsible for the propagation of borers and *pyrilla* in early spring.

A number of natural enemies of cane pests were also studied at Muzaffarnagar. *Goryphus* sp. (*Ichneumonidæ*), *Rhaconotus scirpophagæ* Wilk. (Braconidæ) and *Telenomus* sp. (Scelionidæ) were found effective against the top-borer and *Tetrastichus pyrillæ* Crawf. proved of value by parasitising eggs of *pyrilla*.

In ASSAM, the top-borers, *Scirpophaga aurifolia* and *S. nivella* and the stem-borers, *Argyria sticticraspis* and *Diatræa venosata*, were the major pests at Jorhat and all except the last species continued to do damage throughout the year. Selection of borer-free setts for planting and removal of plants showing dead-hearts were found to be useful preventive measures, while light traps were effective against top-borers. Experiments with Napier grass showed that this host, being much less attacked by borers than sugarcane, could not be employed as a trap crop. In the Surma Valley, stem-borers, white ants and mealy bugs were the commonest insects and were controlled by systematic removal of affected canes and irrigation with crude oil emulsion.

Work at Coimbatore in the MADRAS Presidency showed the top-borer, *Scirpophaga* sp., to be the most important pest and the possibility of its control by two larval parasites, *Stenobracon nicevillei* and *Elasmus zehntneri* Ferr., was investigated. The egg parasite, *Trichogramma minutum* Riley, was also studied for the control of the stem-borer, *Diatræa* spp. Meanwhile, collection of the egg masses of the moth in the early stages of the crop and destruction of shoots showing dead-hearts were found useful in reducing the pest.

In MYSORE, stem-borers were reported to be successfully controlled by a combination of cultural and biological methods. The former consisted in earthing up cane plants when they were about four weeks old, particularly in a bad borer season and without waiting for any dead-hearts to appear, and the latter in releasing about ten lacs of beneficial egg parasites (*Trichogramma minutum*) in young cane fields.

Cotton. An intensive ecological study of the parasites of cotton pests was initiated in the laboratory of the Imperial Entomologist at New Delhi. Observations on the development of *Microbracon lefroyi* D. & G., and its host *Earias* spp. were made to determine the threshold of development and optimum conditions for the multiplication of the host and the parasite.

Contrary to previous records, both *E. insulana* and *E. fabia* infesting *bhindi* (*Hibiscus esculentus*) were found to be parasitised by *Microbracon lefroyi*. In May both the species were found parasitised to the extent of 10 per cent in the field.

In the PUNJAB, work on the white-fly of cotton, which was started about six years ago, was concluded. The evidence collected shows that although this insect is responsible for heavy losses, it could not by itself bring about the so-called " failure " of cotton crops during the past years as has been believed by some workers. Spraying with rosin compound has proved to be an effective method of controlling this pest and the cost of spraying operations on large scale comes to about Re. 1-8 per acre.

A clean-up campaign for the removal of sprouting cotton, the main source of food for the Spotted Boll-worm in the Canal Colonies after the year's harvest, was carried on in certain selected areas to demonstrate to the cultivators the effectiveness of this method of control. Observations in the eastern, central and sub-montane regions showed that in addition to cotton sprouts other plants such as *Malva parviflora*, *Abutilon indicum* and *Malvestrum tricuspidatum* served as hosts for the Spotted Boll-worm and any clean-up scheme in these areas must include the eradication of these plants.

In the UNITED PROVINCES, the area for the field trial of Pink Boll-worm control was increased. The Pink Boll-worm being the most important insect pest of cotton in the province, it is estimated that Rs. 15-20 per acre in an average season is added to the value of the crop in areas where control against this pest is applied. The control consists of organised sun-heating of cotton seed in villages and machine-heating of factory-ginned seed in bulk.

The Pink Boll-worm, which is a serious pest of cotton also in the CENTRAL PROVINCES AND BERAR, was under observation at Nagpur and Akola. Removal and destruction of shed material every morning from the cotton fields, when there was wind without rain during the previous night, from October to end

of December, was under trial and found to reduce damage by Pink and Spotted Boll-worms appreciably. An egg parasite (*Trichogramma minutum*) of the American Boll-worm, *Heleothis armigera* Hb., was also studied.

At Coimbatore, infestation of Pink Boll-worm on Cambodia cotton during March-April was much higher than that of the Spotted Boll-worms. Work on the cotton scale, *Saissetia nigrum*, which assumed the status of a pest at times, showed that the presence of an alternative host tree results in heavy infestation of the neighbouring cotton crop. A Chalcid, *Scutellista cyanea*, parasitised the scales to the extent of 60 per cent during November and December. Work on the control of the stem weevil, *Pempheres affinis* Fst., was continued at Coimbatore and at Koilpatti. Parasitisation, which was confined to the grub stage, was not found to be of economic value, but four varieties, namely, Quebradinho, Verdao, Moco and Bourbon, proved resistant to the pest and were considered useful for breeding purposes.

Work at Parbhani (HYDERABAD-DECCAN) seemed to confirm previous year's findings on the boll-worm pests. The Pink Boll-worm passes its resting stage in the soil and to a smaller extent in the stored seed cotton and does not (as in the United Provinces) survive in the stored seed. Complete removal of cotton stalks soon after final picking, completion of cotton ginning before May and prohibition of growing of *bhindi* in the hot weather are considered effective in reducing the pests.

Paddy. In ASSAM, *Spodoptera mauritia* was successfully controlled by catching the moths in the Andres Maire traps, destroying the caterpillars with hand or by flooding, and exposing and killing the pupæ from their hiding grounds by scraping field-bunds, etc. Crabs also did serious damage to paddy seedlings on the Habiganj Farm.

Investigation on the *gangai* disease of paddy in the CENTRAL PROVINCES was started in April 1936. The life-history of the midge, *Pachydiplosis oryzæ*, responsible for this hollow " silvery shoot " in diseased plants, was studied, and a

complete life-cycle was found to last fourteen to twenty-one days during the paddy season, *i.e.*, from August to November. A number of grasses found in and near paddy fields after harvest time were examined for galls similar to those in paddy suffering from the *gangai* disease. In certain cases, specimens of *P. oryzæ* were bred out from these grass galls. It was observed that early ripening varieties were attacked less than late ripening varieties. Two Chalcidoid and a Platygasterid parasites were also reared from the " silvery shoots " of affected paddy plants. One of the former parasitised the pupa of *P. oryzæ*, while the *Platygaster* sp. was parasitic on the egg. The last-named parasite occurred in large numbers and possibly exercised some check on the pest. Heavy rainfall at the time of the emergence of the midges from the " silvery shoots " was observed to affect them very adversely with the result that the crop was saved from a subsequent attack.

At COIMBATORE, investigation on *Spodoptera mauritia* was continued. Mass breeding of the pest showed that during days of abnormally low humidity and high temperature there was great mortality among moths and eggs. Work on the paddy stem-borer, *Schœnobius incertellus*, failed to show any varietal resistance. Parasitisation of this pest by *Trichogramma* sp. and *Tetrastichus* sp. was common from December onwards. The paddy grasshopper, *Hieroglyphus banian*, occurred in large numbers in August and September and some individuals were found parasitised by a nematode, *Mermis nigrescens* Duj.

In TRAVANCORE, *Spodoptera mauritia* was successfully controlled by dusting with Paris Green.

Tea. In TRAVANCORE, tea bushes were sprayed with fish-oil rosin soap (2 per cent) against *Helopeltis* at intervals, beginning in April, with a view to seeing if such operations would free the bushes from the pest during the period of its greatest prevalence, *viz.*, July to October. The results showed that although there was a marked improvement immediately

after spraying and for a little time afterwards, the improvement was not maintained and at the end of August sprayed bushes had no advantage over unsprayed ones. The shot-hole borer, *Xyleborus fornicatus* Eich., occurred as pest on several estates. As the pest was found only in certain localities, pruning and burning of infested shoots was considered an effective control. Adequate manuring of the infested fields was recommended as an additional preventive measure. Damage to tea bushes was caused by termites *Coptotermes* sp. and *Calotermes* sp. in Mundakayam and the Anamalais hills respectively. As dead wood is necessary for initial infection by *Coptotermes* sp., the prevention of " wood-rot " and " die-back " after pruning and the elimination of tree stumps from cultivated areas were suggested as a preventive measure. Injection of Paris Green into attacked bushes was recommended against *Calotermes* sp.

Coffee. Damage from the red coffee borer, *Zeuzera coffeæ* Nietn, was reported from Central TRAVANCORE and the Anamalais. The pest is chiefly noticed during pruning and the burning of attacked branches and injection of petrol into the tunnel if the injury extended below the pruning level was considered adequate control.

Tobacco. Work on the insect vectors of tobacco leaf-curl was continued at PUSA by the Imperial Entomologist. Transmission experiments confirmed the previous year's finding about the role of the white-fly, *Bemisia gossypiperda* M. & L., as the vector of the disease. While the disease could be transmitted by this insect from sunn-hemp to tobacco, from diseased to healthy tobacco, from diseased to healthy sunn-hemp, the white-fly could not transmit the disease from tobacco back to sunn-hemp, in many cases. *Ageratum conyzoides*, one of the common weeds at Pusa, was found to be another alternative host of the virus.

Laphygma exigua was noted for the first time as a pest of tobacco in nurseries in South India. The insect was observed

to breed throughout the year on a sand dune weed, *Gisekia pharnaceoides*, and was found attacked by two Tachinid parasites, *Sturmia inconspicuoides* and *Actia monticola*, and a Reduvid bug, *Rhinocoris fuscipes*. Dusting with calcium arsenate proved effective.

Linseed. Work on the morphology and bionomics of the linseed midge, *dasyneura lini*, and its Chalcid parasite (*Systasis* sp.) was continued at PUSA. *Cajanus cajan* was found to be an alternative host of the midge which seemed to pass the unfavourable summer season in a quiescent larval stage. The relative incidence of the pest on various varieties of linseed was found to be dependent on the time of their flowering. The parasite laid its egg inside the unopened and crumpled buds of linseed and not on the host body direct and the hatching grubs destroyed three to four host larvæ each.

The linseed semilooper, *Plusia orichalcea*, was found seriously damaging linseed leaves at the Kalimpong Farm in BENGAL. It was controlled by hand-picking and spraying with lemon chrome.

Fruits. At NEW DELHI, the life-history of *Dacus longistylus* Wied. infesting *ak* (*Calotropis* sp.) fruits was under investigation.

In the PUNJAB, the alternate host plants of the woolly aphid and the comparative susceptibility of stocks of various varieties of apple to this pest were studied. Large-scale spraying was done against the citrus psylla, the citrus white-fly, mango hoppers and the San José scale.

At Chaubattia in the UNITED PROVINCES, pests of fruit trees were studied with special reference to soil conditions. Major pests of apple trees included the apple root-borer, *Lophosternus hugelii* Redt., the woolly aphid, *Eriosoma lanigerum* Hausn., defoliating beetles (*Adoratus* and *Anomala* spp.), the apple stem-borer, the apple shoot-borer (Fam. Cossidæ) and the tent caterpillar, *Clissocampa indica* Wlk. A series of experiments with soil fumigants for the control of the apple root-borer

indicated the effectiveness of fumigation up to a depth of three inches. Fish-oil-rosin-soap, tar oil and kerosine oil emulsion proved effective as winter sprays against the woolly aphid, the first named being superior to the other two. Observations on the life-history of the woolly aphid showed that the migration of aphids from root to shoot and *vice versa* occurred throughout the year, except for about two months during the coldest part of the season, and that the insect had no alternative host plants, the asexual females remaining on the apple trees all the year round. The relative susceptibility of different foreign and local stocks to woolly aphid attack was also studied. Four of these stocks, *viz.*, Merton 799 and 793, Malling type XIII and *Pyrus baccata* (a local stock), having been found to be resistant to woolly aphid attack, their behaviour in relation to this pest in four different soils was under investigation. The shoot and stem-borers of apple seem to be identical since after hatching the larva bores into the shoots and goes on attacking twig after twig till the following May when it crawls down and attacks the stem. Collection of egg masses and nests proved effective against the tent caterpillar, which fed mainly on leaves of apple, pear, cherry and plum. Lead chromate, lead arsenate and lime and naphthalene emulsion were found useful against defoliating beetles. Fish-oil-rosin-soap and soft soap were tried with good results against *Diaspis* sp. In the Agricultural Gardens at Cawnpore, grease-banding of mango trees was found an effective practical control against the mango white bug, *Monophlebus* sp.

In the MADRAS Presidency, *Chœtodacus ferrugineus* Fb., was found breeding in fruits of *Solanum auriculatum* (and not in *S. verbascifolium* as reported last year) throughout the year. Parasites bred from the fruit-fly larvæ included *Opius* (*Biosteres*) *longicaudatus* Ash., *O. incisi* Silv., and *O. persulcatus* Silv., while *Spalangia philippinensis* Full. and *Dirhinus auratus* were found parasitising the pupæ.

At the request of the Director of Agriculture, NORTH-WEST FRONTIER PROVINCE, the Imperial Entomologist undertook an

investigation of fruit flies in that area with a view to their control. A preliminary survey revealed the presence of the following species:—*Chætodacus ferrugineus* Fb., *C. zonatus* Saund., *C. cucurbitæ* Coq., *Carpomyia vesuviana* Costa., *Myopardalis pardalina* Big., and *Dacus oleæ* Silv., the first species being very serious on loquat and apricot at Kohat during last May. Arrangements were made for the trial of several baits and sprays. Other serious pests were San José Scale in the Kurram Valley and Hazara district and aphids attacking peaches. The latter were controlled by a rosin-tobacco mixture introduced by the Department of Agriculture, North-West Frontier Province. The Imperial Entomologist also reported the occurrence of the Codling Moth in the Parachinar district of the North-West Frontier Province.

The Imperial Entomologist started a survey of the distribution and status of the Codling Moth in BALUCHISTAN. The preliminary survey showed that the insect is widely distributed in the province and constitutes a very serious pest in Quetta-Pishin, Fort Sandeman and several other areas. In Baluchistan, the bud moths, *Spilonata ocellana* Dauds. and *Cacœcia subsidiaria* Meyr., were serious on blossoms of apple, plum and apricot. Fruit-flies (*Chætodacus ferrugineus* Fb. and *C. zonatus* Saund.) did considerable damage to fruits of peach, apple, pear and pomegranate in Fort Sandeman and Loralai districts and fruit flies (*Myiopardalis pardalina* Big. and *Chætodacus cucurbitæ* Coq.) to melon crop in Quetta-Pishin district. Lead arsenate sprays were found effective against codling and bud moths, rosin-fish-oil-soap against green and black peach aphids and lime sulphur against scale insects.

Vegetables. At NEW DELHI, fruit-fly maggots (*Chætodacus* sp.) seriously damaged crops of *Cucumis melo* (*kharbuza* and *kakri*) by boring into unripe fruits. *Solanum melongena* offered an attractive host to *Pœcilocerus pictus* adults and hoppers after they had defoliated plants of *Calotropis gigantea*. The pest attacked several other cultivated crops. The

potentialities for doing harm of this new pest were under investigation.

In ASSAM, a serious infestation of red ants on khol khol and cauliflowers was controlled by timely irrigation with diluted phenyl and fumigation of soil with paradichlorbenzene. Tobacco decoction proved effective against larvæ of cabbage butterfly.

In the MADRAS Presidency, dusting with flowers of sulphur was found an effective control against the chilli thrips, *Scirtothrips dorsalis*, and derris dust against the diamond-back moth of cabbage, *Plutella maculipennis*. Studies with the leaf and bud caterpillar pests of *Moringa* showed that these belong to two species of moths, one of which is *Noorda blitealis*. Spraying with calcium arsenate was found effective against these caterpillars, while Bordeaux mixture acted as a repellent in the case of the bud moths. Two other pests of *Moringa* were *Eupterote mollifera* and *Stictodiplosis moringœ* (an Itonidid). The former was controlled by spraying with kerosine emulsion, and the latter is under study having been noted for the first time in South India.

In the BOMBAY Presidency, a home-made nicotine spray or tobacco ' dhus ' extract was found very effective in controlling aphis on cabbage, provided three sprayings were given.

Stored grain pests. At NEW DELHI, the rice moth, *Corcyra cephalonica*, was under study. The insect was bred on wheat. High temperatures and low humidity prevailing in May and June were very unfavourable to this as well as other stored grain pests under study, *e.g.*, *Sitotroga cerealella* and *Calandra oryzæ*. The larvæ of the latter left the grains in large numbers and died on the surface. Some experiments were performed to determine the repellent effects of ashes and various clays on the pest.

In ASSAM, carbon bisulphide and paradichlorbenzene were found effective fumigants against *Calandra oryzæ* and *Sitotroga cerealella* in paddy seeds and against Bruchids in pulses.

Bee-keeping on the Jorhat Farm, Assam

At COIMBATORE, observations with different varieties of paddy seeds indicated that GEB 24, A 1, A 3, A 5, and M 5 showed varying degrees of resistance to paddy borer attack, the puttoos (Red and White) being highly susceptible. Tests with the *cholam* seeds As 29, As 1575, As 367 and As 809 showed that the last two varieties were more susceptible to the grain weevil attack than the first two. Experiments to see if the storing of *cholam* seeds with chemical powders such as sodium fluosilicate, borax, calcium sulphate, copper carbonate, etc. was effective in preventing the weevil attack were in progress.

In MYSORE, none of the powders made from *Tephrosia candida* and *Derris*, which successfully killed pests, such as *Bruchus chinensis*, proved effective against the rice weevil *Rhizopertha* sp.

7. Useful Insects

Apiculture. Interest in bee-keeping has greatly increased in recent years, especially among educated public. The Imperial Entomologist supplied hives and comb foundation for rearing the Indian bee to numerous correspondents. In addition to bee farms maintained in the PUNJAB and in the MADRAS Presidency, several apiaries were started at Sylhet in ASSAM. Training and demonstration centres were maintained in the Punjab, Mysore and at Coimbatore. One landlord in South India maintained a colony of Italian bees with success. Special studies were made of bee pasturage plants in the Punjab and at Coimbatore. At the latter station, bee enemies and their control were also under investigation. The life-history of a Braconid parasite of the wax moth, *Galleria melonella*, was studied and the lesser wax moth of Europe, *Achræa grisella*, was noted for the first time in South India.

Lac and Shellac. *Aspidiotus orientalis* Newst. was the only important pest of lac host trees at Namkum. The fifteenth generation of the parthenogenetic strain of the lac insect developed satisfactorily, and no diminution in the

quantity of resin or effect on sex-ratio was observed. Attempts are being made to produce standard strains of lac insects by cultivation *in vitro*.

The average parasitism of *L. lacca* for the year was 6·2 per cent, and the percentage of hyper-parasitism also remained low. *Eublemma amabilis* Moore and *Holcocera pulverea* Meyr. were bred from samples of lac received from Java. Tests on the longevity of *H. pulverea* showed that the adults supplied with 2 per cent solution of cane sugar or glucose lived longer than those supplied either with water or kept without water.

The average percentage parasitism of *E. amabilis* by *Microbracon greeni* Ashm. was 18·1, as compared with 13·1 in the previous year. The effective rate of breeding the Braconid varied from 51 to 79 per cent and the percentage of females bred 41 to 83 per cent. For purposes of oviposition, a concentration of ten males to twenty female parasites gave better results than five to fifteen. *M. greeni* oviposited on *Cataglyphis bicolor* and *Platyedra gossypiella* Saund.; adults reared from the latter oviposited freely on larvæ of *E. amabilis*.

During the year twenty-three generations of *Microbracon hebetor* were bred. The Braconid oviposited freely on a wide range of hosts in the laboratory.

The average parasitism of *H. pulverea* by *Apanteles tachardiæ* during the year was only 3·6 as compared with 6·6 of the previous year. This Braconid was successfully reared in the laboratory, but attempts to rear the Ichneumonid *P. testaciecollis* failed. A Bethylid ectoparasite of *H. pulverea* larva was identified as a species of *Perisierola*. One individual of *Elasmus albomaculatus* Gah. was reared from *H. pulverea* larva.

With a view to bring home to the cultivator the practical results in lac cultivation achieved at the Indian Lac Research Institute, Ranchi, four trained demonstrators have been deputed in the Chota Nagpur Division of Bihar and two in Malda and Murshidabad districts of Bengal.

Chemical Researches. The process of bleaching lac has been thoroughly investigated and an improved test for the bleaching capacity of lac has been evolved. Technical methods for the isolation of aleuritic acid and the hard resin from shellac have been worked out. Analytical methods for determining the adulterants, orpiment and rosin in shellac were investigated. Oxidation of shellac and aleuritic acid and distillation of lac have yielded useful products which also give a clue to the constitution of shellac. The condensation of glycerine, phthalic anhydride and aleuritic acid has yielded an adhesive with valuable properties.

The possibility of shellac moulding by the injection process has been demonstrated and when the technique has been perfected, the rate of production, which is a very important factor in the moulding industry, could be considerably increased.

The Indian Lac Cess Committee also maintained the London Shellac Research Bureau which again did excellent work on new uses for lac in modern industry and to promote the greater consumption of shellac. The Committee also made a grant to the New York Shellac Research Bureau maintained by the United States Shellac Importers' Association for similar purposes. For particulars of the important work now in progress in the industrial field reference is invited to the reports of the Indian Lac Cess Committee and the Bureaux mentioned.

8. Sericulture

THE protective duties came into operation on 1st May, 1934, but the industry continued to be in a depressed condition. A rise in the price of raw silk during a part of the year under review had, however, a stimulating effect in all silk-growing areas.

MYSORE. The total area under mulberry decreased by about 3,400 acres to about 25,132 acres, but there was an increase again and towards the end of the year it was estimated that about 5,000 acres had been added to the acreage. The system of paying a bonus at the rate of two annas per

tree, sanctioned during the year, encouraged tree plantation and the Department supplied 5,000 saplings free of cost. About 116 cart-loads of green cuttings were also supplied free of cost to rearers.

For production and supply of disease-free seed, the following agencies were at work, *viz.*, nine Government farms and grainages, nineteen aided grainages and eight Co-operative Sericultural Societies. The Government sanctioned an additional grant of Rs. 10,000 for increasing the work of the Government grainages. The aided grainages were strengthened by four new ones, though two old ones did not work. Ten of the eighteen Co-operative societies did no work. To encourage aided grainages, donations amounting to Rs. 200 were received by the Mysore Silk Association for instituting shields to be awarded by competition.

A seed campaign, aiming at the production of sufficient seed-cocoons from microscopically examined cellular layings, engaged the services of 724 private rearers, registered as selected seed-rearers, to whom 485,755 disease-free layings were supplied free of cost. These seed-rearers raised about 655½ lakhs seed-cocoons, which were purchased by Government and aided grainages and Co-operative Sericulturists' Societies, for preparation of disease-free layings for supply to general rearers and also by some general rearers who reared from seed-cocoons direct. The results were satisfactory. The total production of disease-free layings by the Government, aided and Co-operative grainages was 77,15,661 layings against about 59,00,000 in 1935-36. The actual supply to general rearers was 43,42,756 layings by Government grainages to 12,424 rearers, 31,51,676 layings by aided grainages including four Co-operative Societies recognised as aided grainage to 5,259 rearers and 46,058 layings by four other Co-operative societies. The total supply amounted to about 77,16,000 layings during this year. The races of worms reared were Mysore pure and cross-breeds between Mysore female and foreign univoltine male. For the production of cross-breeds, the Government grainages supplied

1,07,957 disease-free layings of foreign univoltine races free of cost to special selected rearers as against 74,530 layings during the previous year. The cost of producing one hundred disease-free layings in Government grainages was Re. 0-11-4. The twelve aided grainages permitted to produce cross-breeds, produced 18,35,289 such layings against 11,73,044 layings during the previous year. Seed was supplied to depressed classes at half rates.

Research was continued on mulberry and its cultivation as well as on races of worms. Groundnut cakes alternated with cow-dung proved to be the best manure. Mulberry from seedlings proved to be better than that from cuttings.

Experiments were continued to find out the best foreign races of worms suitable for hybridising in different seasons. Experiments were also continued on feeding worms with mulberry grown in different ways.

Refrigeration trials now completed showed that multivoltine eggs put in cold storage on the second day and kept there up to twenty days hatched satisfactorily. Refrigeration experiments were undertaken with multivoltine seed-cocoons and hybrid layings.

Experiments in connection with reeling showed that cocoons conditioned with steam reeled better than those conditioned with hot air or sun.

The Government Silk Filature worked for twenty-seven days producing 7,498 lbs. raw silk. None of the domestic basins worked during the year.

The cocoon market, started at Channapatna in 1935-36, continued to progress. A second market was started at Mugar. Sericultural loans amounting to Rs. 1,250 were granted to eleven sericulturists.

The Mysore Silk Association, which receives a grant of Rs. 1,000 per year from the Department, continued to function on behalf of the industry and to publish the fortnightly reports regularly.

The Board of Sericulture discussed the proposals of the Silk Association and submitted recommendations to Government.

The buildings of the Spun Silk Mills, of which the foundation was laid by His Highness the Maharajah in March, 1937, were nearing completion. The mills provided a market for waste silk.

The total expenditure of the Mysore Department of Sericulture amounted to Rs. 1,57,000 as against Rs. 1,42,000 during the preceding year.

BENGAL. The climatic conditions were rather unfavourable during the year, with droughts and unusual rain and floods, which caused damage to mulberry as well as to rearing houses. The Sericulture Department had hitherto dealt with only the first stage of the silk industry, *viz.*, rearing. The sharp fall in the price of raw silk coupled with import of foreign raw silk at low prices seriously affected the reeling industry which contracted. This was followed by similar contraction in the rearing industry. It became necessary to resuscitate reeling so that cocoon-rearers might find a ready sale for cocoons. The Department therefore undertook work on reeling. Schemes for introduction of improved machinery and methods of reeling and for a conditioning house to test and certify the raw silk were under consideration. A reeling institute under the name of the Peddie Reeling Institute was started at Malda and a new simple reeling machine worked with pedal motion, a re-reeling machine and a new type of cooking and reeling oven were introduced.

The department maintained seven nurseries for production and supply of disease-free layings and seed-cocoons and 463 ex-students and selected rearers were also helped and supplied with 4,29,488 layings to produce disease-free seed for supply to the general rearers. The total outturn by the nurseries and selected rearers amounted to 64,555 *kahon* (1 *kahon* = 1,280).

The races of worms reared were the indigenous multivoltine *Nistari* and *Chotopolu* and the indigenous univoltine *Boropolu*.

Boropolu eggs, hibernated at 40° F., gave successful hatching. Several fixed hybrid multivoltine races were introduced from Burma and tried, of which one named *Nistid* seemed hopeful.

Experiments were in progress on improvements of races of worms and on growing mulberry from grafts with the help of grants sanctioned by the Government of India.

Sericultural training was arranged for in two schools attached to two nurseries, by employment of rearers' sons in nursery work and in village primary schools.

The demonstration and propaganda staff helped in the production and distribution of disease-free layings, in disinfecting houses and appliances, in taking measures for controlling diseases, in getting houses improved, in demonstrating improved methods of rearing and in collecting statistics. The subvention received from the Government of India amounted to Rs. 39,000.

Agricultural loans to the extent of Rs. 6,548 were issued through the Departmental staff who realised Rs. 4,645 due on account of past loans. Rewards to the extent of Rs. 10,000 were given to selected rearers out of the Government of India's subvention. Students were given free grants of Rs. 1,500 for building model houses and undertaking seed production.

The affairs of the Bengal Co-operative Silk Union were looked into with a view to improve them.

MADRAS. The Mysore race of worms is reared here and the rearers prefer seed imported from Mysore to that produced locally. The Department is trying to popularise locally produced seed. The Department is also popularising cross-bred seed obtained from the Mysore race female crossed with males of Chinese and other univoltine races. During the year about 75,000 cross-bred layings were supplied against about 12,500 supplied during the previous year.

For arranging the supply of disease-free seed there were three aided grainages which produced about 2,30,000 layings and fifteen moth-testers stationed in as many important

villages, each with charge of several neighbouring villages and expected to test about two lakh moths in a year. They tested about 24,74,000 layings against about 11,02,000 during the previous year.

The Department, which received a subvention to the extent of Rs. 14,700 from the Government of India, maintained four silk farms for rearing and mulberry cultivation. Manurial trials, as well as budding and grafting on mulberry, were carried out and mulberry cuttings were supplied to private persons. Five demonstrators stationed at five different places demonstrated proper methods of rearing.

Silk reeling on an improved Japanese type of foot-reeling machine with four reels was demonstrated.

Preparation of silkworm guts with different methods was carried out and a consignment of one lakh guts was sent to England with a view to test commercial possibilities.

In the absence of an outlet for *Eri* silk cocoons, little development had been possible. Worms were raised successfully in Coonoor Farm, a boy from a Christian Mission Training School was trained in spinning and eggs were supplied to several individuals.

Research on diseases of silkworms carried out during the year included investigation into factors affecting pebrine. The experiments went to confirm the facts already known that a diseased lot could be rendered absolutely disease-free in the course of a few generations, that healthy lots became infected when reared side by side with diseased lots or in an infected room, that there was suspicion of transmission of disease through the male moths, that in a pebrinised lot the scale dust of the moths contained pebrine spores, that pebrine spores adhered to egg shells when the eggs were exposed to this dust and that there was a possibility of infection of the worm unless such eggs were washed with formalin and that the dung of cattle fed with pebrinised litter contained pebrine spores, necessitating precaution in the use of cow-dung in smearing rearing trays.

ASSAM. There were two sericultural stations, at Titabar and Shillong. The Titabar station carried out work in connection with three kinds of silk worms, *viz.*, *Muga*, mulberry (locally called *pat*) and *Eri*. The Shillong station, where rearing can be carried out from about the end of March to about the middle of October, dealt with mulberry and *Eri* silkworms. At both the places, foreign univoltine and bivoltine mulberry silkworm races were under experiment.

The sericultural area in the province was divided into twenty-seven operators' circles with control over 116 model rearing houses. The stations as well as the circles produced disease-free layings and seed-cocoons. The Titabar Station supplied forty seed-cocoons and 32,950 layings of *Muga*, 45 seed-cocoons and 8,594 layings of *Eri* and 27,173 layings of mulberry silkworms. The Shillong Station supplied 17,933 layings of mulberry and 420 layings and one hundred seed cocoons of *Eri*. The circles produced a total of 109,555 layings and distributed 69,878 layings and sold 355 *charkas* and five *Muga* reels.

BURMA had seven sericultural stations for the maintenance of stocks of fixed hybrid races of worms, for research in the production of mulberry grafts, of new races of worms and of first-generation hybrid worms, for supplying of seed to rearers, and for training of rearers in mulberry cultivation, rearing and reeling. The Department also supplied to rearers the new type treadle reeling machine and pruning shears for mulberry. The Roman Catholic Mission at Leiktho made reeling machines and supplied them cheaply to rearers. The total seed supply made by the different stations during the year was 35,936 layings and 72,195 seed-cocoons. The following fungi were identified as affecting mulberry, *viz.*, *Corticium salmonicolor*, *Diplodia* sp., *Rhizopus* sp. and *Fusarium* sp. Scale insects affecting the mulberry stem were controlled by rosin-compound spray and borers in the stem by injection of carbon bisulphide.

CHAPTER VII

AGRICULTURAL MARKETING*

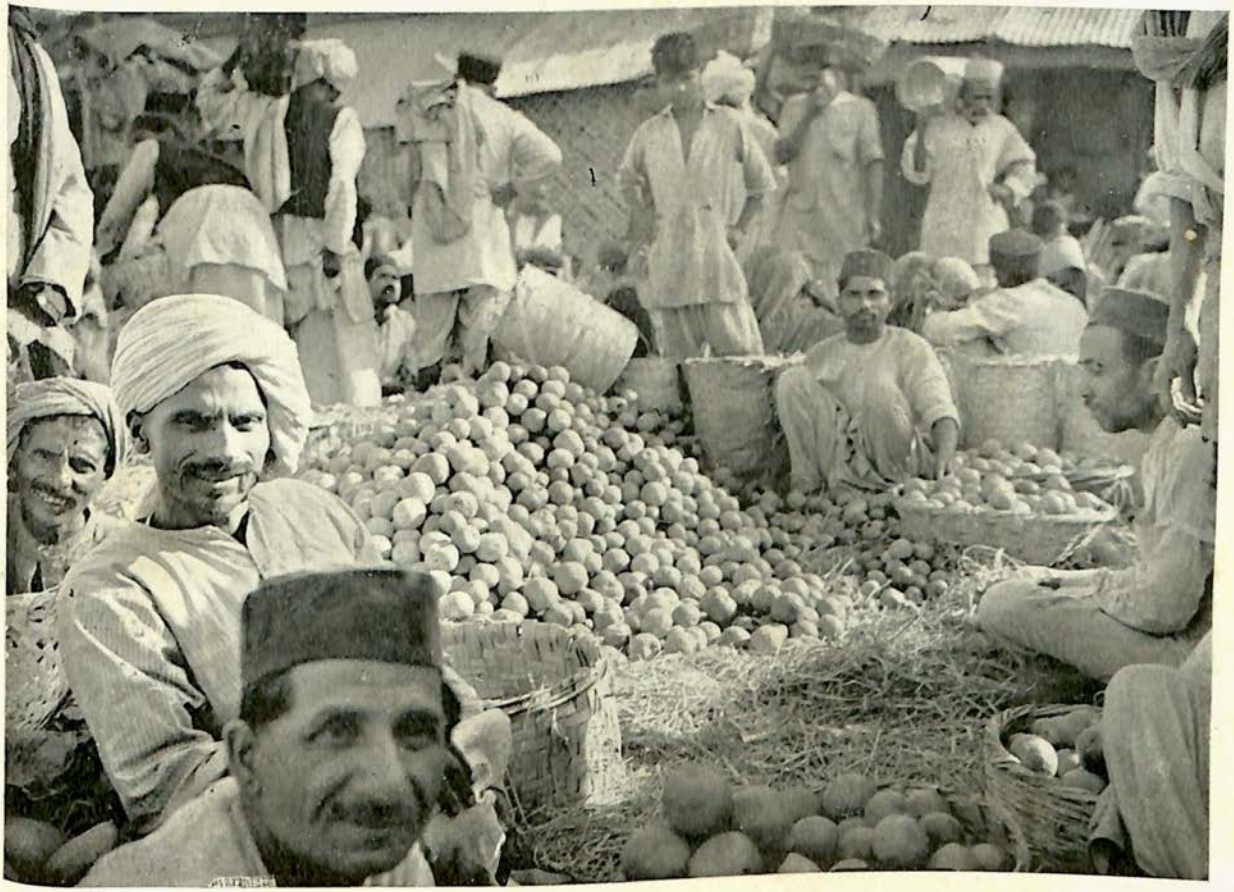
DURING the year surveys were continued in regard to rice, wheat, linseed, groundnuts, tobacco, fruits, milk, eggs, live-stock and hides and skins and also in respect of markets and fairs and co-operative marketing. At a conference between the Central Marketing Staff and Senior Marketing Officers in provinces and States held at Delhi in April, 1936, it was agreed that as soon as the completion of the enquiries regarding any of the foregoing commodities permitted, survey work should be commenced on the following:—

Cereals—Barley, gram and maize.
Oilseeds—Coconuts, mustard seed, rapeseed and *toria*.
Fruits—Mangoes.
Vegetables—Potatoes.
Special crops—Coffee.
Animal Husbandry products—Sheep and goats, wool and hair and ghee and butter.

Arrangements were made for the analysis of samples of new commodities at various centres. By courtesy of certain large exporters at Calcutta and Karachi, an analysis was made from their books of the quality of exported hides and skins on the basis of trade selections on the Hamburg system of classification.

The first report issued by the Agricultural Marketing Adviser gave an exhaustive picture of the marketing of wheat in India. It contains considerable material which should be of interest to all those connected with the wheat trade. Its price was specially fixed so low as Re. 1-4 per copy so that it might suit

* The assistance of Mr. A. M. Livingstone, Agricultural Marketing Adviser to the Government of India, in the preparation of this Chapter is gratefully acknowledged.



Sorting of oranges in Delhi wholesale market

(With the kind permission of Mr. H. C. Javaraya, Senior Marketing Officer, Old Delhi)

all pockets. Copies of the report (Report on the Marketing of Wheat in India) are available for sale at all Government book-depots and in the office of the Manager of Publications, Civil Lines, Delhi. Similar reports on linseed, tobacco, grapes, eggs and cattle are under preparation.

The question of cold storage and refrigerated transport which had been engaging the active consideration of army authorities was also taken up by the Agricultural Marketing Adviser, who acted as liaison Officer between various Departments and attended to enquiries from the trade and general public concerning cold storage. At the instance of the army authorities, a company (The Indian Cold Storage Company, Delhi) was formed for the erection of cold storage depots at several places in Northern India. It was anticipated that these depots, when erected, would cater for the requirements of both military and commercial interests. (The cold storage proposals were linked with a scheme for the erection of an abattoir at Lahore which had subsequently to be abandoned).

Although development work was mainly the concern of provincial staffs, certain experimental grading and packing stations were established for hides (at Agra and Delhi); fruits (oranges at Nagpur, plums and peaches at Tarnab, North-West Frontier Province and grapes at Nasik); eggs (at Pabbi in the North-West Frontier Province, and Kottarakara in Travancore); and for *ata* (flour) from washed and conditioned wheat ground at Delhi. The system of grades adopted at these experimental stations was based on the commodity analyses and discussions with representatives of the trade. Soon after this work started, necessity was felt for taking suitable steps to protect these grade designations and marks from being copied or otherwise misused. The Agricultural Produce (Grading and Marking) Act, 1937 (Act I of 1937), was accordingly passed by the Central Legislature in February, 1937. Rules were made under the Act prescribing grade designations and standards of quality for tobacco, oranges, grapes, eggs, hides and skins and published in the Gazette of India, dated 27th February, 1937, and 20th March,

1937. The General Rules made at the same time empower the Agricultural Marketing Advisor to issue Certificate of Authorisation to suitable persons who wish to grade and mark their produce with the prescribed designation marks.

As a general policy it is hoped that, as far as many of the heavy commodities are concerned, grades and standards will be controlled by suitable trade associations like the East India Cotton Association at Bombay. In pursuit of this policy and with a view to encouraging and developing the sense of corporate responsibility for improving marketing methods, the Central Marketing Staff held several conferences, with various trade and manufacturing interests concerned with the marketing of different commodities. In the course of the year, Grain Trade Associations and millers co-operated with the Central Marketing Staff in formulating the basis of an all-India standard contract for wheat and linseed. As a result of mutual discussion, the Federation of Indian Tanners was established at Cawnpore and the Indian Tobacco Association at Guntur. Part of the object of both these bodies is to maintain grade standards and promote their use in the trade. Discussions were also held with sugar interests with a view to establishing a comprehensive association for controlling " futures " trading on the basis of defined standards.

A bulletin giving the prices (both ' ready ' and ' futures '), stocks and movements of wheat, linseed and rice is compiled at the Headquarters from information received from the important markets of Amritsar, Lyallpur, Karachi, Bombay, Calcutta and Hapur. This is passed on to the All-India Radio, Delhi Station, from where it is broadcasted (both in Urdu and English) every Sunday evening and also to the press for publication on Mondays. The daily closing prices of wheat at Hapur are also broadcast from Delhi every evening.

Apart from the work of the central staff, all the local marketing staffs in provinces and States were, by force of circumstances, driven to take up some kind of development work.

For example, the MADRAS local marketing staff formed two fruit growers' associations, the UNITED PROVINCES staff did much work in connection with the Lucknow Exhibition and the establishment of a Fruit Development Board; in ASSAM, the Senior Marketing Officer provided local growers of pine-apples with an outlet for their produce. Nearly all the interests concerned assisted the marketing staffs in speeding up the progress of improved marketing.

CHAPTER VIII

AGRICULTURAL ENGINEERING*

1. Boring and Pumping

In BOMBAY, fifteen boring machines were let out on hire, and two machines were sold. Out of the twelve bores, with a total footage of 1,143 feet, put down by Mr. G. C. Govande of Poona, seven were successful, supplying together 10,000 gallons per hour. On the Belvandi Sugar Farm, five bores were sunk, two of which were successful. Thirteen pumps and pumping plants were hired out during the year.

In BARODA, one hundred wells were bored, giving an increase of 106 kos. The proportion of failures, however, was unduly high at 43 per cent. Ninety-three bores were dynamited, and seventy-nine of them gave increased supply.

An electric pumping set was demonstrated within electrified areas. The multiplication of small individual municipal schemes for the supply of electrical power is rendering more and more remote the prospect of any cheap and reliable rural supply.

The Government is reported to have accepted the proposals of the Commissioner relating to partial insurance of well-borings made by the State service in areas of reasonable water expectancy, improvements in well-blasting procedure accompanied by a system of payment by instalments, and the sinking of wells at the cost of the State under the condition that the well remains the property of the State, and the landowner secures a right to the water on payment of an annual sum.

In the CENTRAL PROVINCES AND BERAR, with the aid of a grant for rural development from the Government of India, the Engineering Section purchased two power-boring plants,

* The assistance of Mr. N. G. Charley, B.E., A.M.I.E. (Aust.), Agricultural Research Engineer to Government, Madras, Lawley Road P. O., Coimbatore, in the preparation of this Chapter is gratefully acknowledged.

each capable of drilling 3½″ bore to a depth of 150 ft. with a 5 B.H.P. engine.

In BIHAR, the boring work is spread over three circles under the charge of well-boring supervisors at Patna, Pusa and Bhagalpur. During the year, 189 2½″ open borings were sunk with a total depth of 14,975 ft. and 135 of them were successful. At the close of the year sixteen borings were in progress. It is reported that this work is passing more and more into the hands of private contractors.

Pumping demonstrations were conducted at twenty-four sites. One 3″ rock-drilling plant was purchased from Messrs. Ingersoll Rand (India), Ltd., for trial borings in the sub-montane tracts of the province where rock is usually encountered at shallow depths.

Thirty-four 1¼″ to 2″ tube-wells, four 2½″ to 5″ tube-wells, and three 9″ to 12″ tube-wells were installed, and at the end of the year ten tube-wells were in course of installation. The installation of small tube-wells is being undertaken by private contractors in most districts of the province and the services of the Agricultural Department for this class of work are not so much in demand.

In the PUNJAB, the usual overhead charge of twelve annas per foot levied by the Department remained in remission, and the keen demand for well-boring continued. Fifty boring plants, each under the charge of a well-borer and mate, were in operation throughout the year. The total number of bores sunk in wells for augmentation of existing supplies was 479, and eighty per cent were successful, that is, they gave an increased supply of not less than twenty per cent of the yield of the well before boring. This percentage is about the average over the past two decades. The total footage bored was 48,656 feet which represents an average depth of bore of about one hundred feet.

Of the 381 successful bores, strainers were used in 205, the average length of strainers being seventeen feet. Most of the

strainers were of the new pottery type, the remainder being of the more expensive Cadmium plated type.

Seventeen open wells were drilled to provide supplies for power pumping. Seven trial bores were sunk in different parts of the province, mostly to depths of three hundred feet and over, with the object of exploring the quality and quantity of underground supplies. In some cases sweet water was not available down to that depth.

Ten tube-wells were completed for Government Departments and private owners, and five more were in course of installation at the end of the year. The demand for large and small power operated tube-wells is increasing with the expansion of the hydro-electric power supply.

In MADRAS, the Engineering Section of the Department of Industries maintained fourteen Armstrong power-drills, one air compressor drill, and 106 hand-boring sets. During the year, 1,034 bores were sunk to a total depth of 66,369 feet which is a little more than in the preceding year. The deepest boring put down by a hand-boring set was 415 feet and by a power-drill 725 feet. Of the 775 successful bores, 543 were for agricultural purposes. Assuming an average yield per bore of fifty gallons per minute, the total quantity of water made available for irrigation purposes was 27,150 gallons per minute, and assuming that only one-third of this supply will be utilised, the borings put down during the year for agricultural purposes may be expected to maintain 2,413 acres of land under irrigation.

Of the twenty-nine artesian springs tapped during the year, twenty-four were in the East and West Godavari districts, and discharged fresh water at rates varying from 4 to 300 gallons per minute, at heights up to four feet above ground level. Four bores in Tanjore Division gave flows ranging up to 1,000 gallons per minute, and up to 9½ feet above ground level. Two others in South Arcot district put down to depths of 172 and 407 feet gave flows of 1,000 gallons and 800 gallons at heights of discharge of 7½ feet and 9½ feet above ground level.

Twenty-two pumping sets were maintained for hire to ryots for irrigation and well sinking, and twenty-three pumping plants were installed for owners, to bring a total of 460 acres under cultivation. Under the Compounding System, owners of pumping sets have their pumping plants inspected and overhauled three times a year on payment of a small fixed annual fee. The number of plants treated under this system during the year was 491 as against 504 in the preceding year.

In SIND, the Agricultural Department assisted in finding suitable sites for sinking wells with the help of the Schmid's Patent Water Finder. Twenty-two sites were selected for sinking new wells, three of which proved successful. Work is in progress at four; on the other fifteen boring has not yet been attempted by the owners. Seventy applications for boring were received during the year under report, out of which only forty could be attended to. Boring has been completed at thirty-five sites and is in progress at the other five sites. Of these thirty-five completed bores, twenty-four were fully successful. Help in the installation of new pumping plants and repairs to the existing pumping plants was given to twenty-five applicants this year.

2. Water-lifts for Bullock-power

IN MADRAS, the Persian wheel, though still a rare type in most parts of the presidency, is becoming better known and more widely employed. The Cooper Persian wheel, made by Messrs. Cooper Engineering Works, Satara, has proved satisfactory and has been installed for service and demonstration on the Agricultural Department's Central Farm at Coimbatore, and on a number of its Agricultural Research Stations. Another make by Messrs. Bulsar Rahat Manufacturing Co., Bulsar, received for test, has given satisfactory service. The improved circular mhote, developed by the Department, has been installed for demonstration on the Central Farm and Research Stations and on several ryots' farms. An improved design of Persian wheel with totally enclosed machine cut gears is in course of development.

In BIHAR, the manufacture of *rahats* (Persian wheels) is being taken up in many places by *mistries* (blacksmiths) and foundrymen, and this is doing much to promote the spread of this type of lift. Demonstration by the Agricultural Department has brought many enquiries, and eight *rahats* were supplied during the year through the agency of the Department.

In SIND, three different kinds of water-lifts were designed during the year. Of these, the one which promised to be the most successful was constructed. The wheel is priced at Rs. 150. It was found to deliver about one cusec of water and required only one bullock to work it.

In the NORTH-WEST FRONTIER PROVINCE, a form of low lift pump, very popular in Egypt, has been installed at the Tarnab Farm. With 1′ 8″ lift, the discharge is two cusecs and it takes about one hour to irrigate one acre. The cost varies from Rs. 300 to 400 according to the lift and another Rs. 100 for brick masonry sump.

3. Bunds and Channels for Irrigation and Erosion Control

IN BIHAR, contour surveys and plans and the design of irrigation channels were made in respect of nine sites ranging in areas from 50 to 2,000 acres. Five bunding schemes for the conversion of *parti* lands, ranging in areas from 50 to 1,000 acres, to paddy lands, and one scheme for the irrigation of 20,000 acres of land in several villages, were inspected and preliminary reports thereon prepared.

In BOMBAY, the study of soil erosion and its control by bunding and other means was continued at various centres.

In HYDERABAD, three embankment schemes were prepared during the year under report for three different places in Raichur district.

4. Agricultural Implements and Machinery

IN the PUNJAB, the post of Agricultural Engineer remains unfilled, and work on implements is at a stand-still. Instead of entrusting the work to an Agricultural Engineer, a scheme

has been drawn up whereby Government will award substantial prizes for improved designs, to be decided by a committee.

In the UNITED PROVINCES, certain changes were made to the Walker seed-drill to adapt it for the sowing of wheat.

In BENGAL, two types of scutching machines for flax were constructed and found to give a higher output and a cleaner fibre than the usual hand methods. The cost of the machines is Rs. 25 each. Experiments in the manufacturing of sugar by the Open Pan system have been continued. There has been a good demand for the Bengal ploughs put on the market last year.

In BARODA, where research work on implements has recently been taken up, a new cultivator and a wheat-threshing implement of local manufacture are being introduced. The manufacture of improved implements is being subsidised in an endeavour to foster a new industry in the State. The Department's eight power-driven and five bullock-power cane-crushing mills were in constant demand throughout the season. Free demonstrations are given in areas where growers are not yet familiar with modern plant; in other parts, they are available only on hire.

In MYSORE, the manufacture of implements was continued at the Hebbal workshops. Improved seed-drills, manufactured by the Department, were tested in the districts with satisfactory results.

In BOMBAY, work was continued on seed-drills, a winnowing fan, the application of ball bearings to the country cart wheel, the soil scooper or basin furrowing implement, and a groundnut lifting implement. Further experiments were conducted in the defibration of cotton seed. Some alterations were made in the feeding arrangements of the De Segundo machine, but the conclusion has been reached that there are no prospects at present for the defibration of cotton seed on a commercial scale, and it is proposed to abandon the experiments and dispose of the plant.

In MADRAS, a steady demand was maintained for the light Cooper and Kirloskar ploughs, about 3,000 of which were sold

through Departmental depots. A new 8″ chilled plough with steel mouldboard, and a light ridging plough with cast chilled body and steel mouldboards were passed for production after satisfactory tests. Eight of the newly developed turmeric polishing machines were supplied for demonstration to various turmeric-growing centres. About 200 tons of turmeric were treated in six machines in the Gobichettipalayam and Erode taluks of Coimbatore district, where the new method has been responsible for savings of up to Rs. 14 per acre. Five more rubber-tyred carts were made for service on departmental farms, and a sixth cart for a demonstrational tour of the Coimbatore district. Tests were made on chaff-cutters, earth-scoops and paddy-hulling machines, and progress is reported in the development of a small cotton seed defibrating machine, wet land puddling implements, and a new system of yoking which employs a leather harness.

The nine power-driven cane-crushing plants maintained by the Department of Industries were fully employed during the year on hire to growers, crushing about 2,557 tons of cane.

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, implements tested and approved include the well-known Ransomes Victory plough, the Raja five and seven-tined spring tooth harrows, the Planet Junior Indigo cultivator, the Parmiter chain harrow which has been found useful for the collection of weeds and stubbles, particularly in double cropping systems where the preparation of land for the second sowing demands their immediate removal, the Brandford weeder, a very useful implement for the breaking of surface crusts, the Gujarat type of country seed-drill, and the Sindhi type of leveller. A thresher and winnower with bullock gear drive, designed at Pusa, gave an output of $3\frac{3}{4}$ maunds of clean wheat grain per hour at a cost of about $5\frac{3}{4}$ annas per maund compared with eight annas per maund in the ordinary treading method. The bullocks convert the straw into *bhusa* while working the gear. Wooden cart bodies equipped with Dunlop roller-bearing wheels and pneumatic tyres are reported to be capable of carrying hay

loads of fifty maunds as against the twenty-five maunds of the ordinary country cart.

Two W.D. 40 McCormick Deering crude-oil tractors, purchased during the preceding year, were operated throughout the year, with a variety of implements, for periods totalling 1,968 hours, consuming between them 3,744 gallons of fuel with consumptions over the various periods ranging from 1·84 to 1·95 gallons per hour.

The Hanomag 55 H.P. crude-oil tractor, with John Deere 4 furrow plough, purchased in March, 1937, has worked very satisfactorily and completed 153 hours of ploughing with an average consumption of 1·85 gallons of fuel per hour.

Ransomes Consul series 3, 4 and 5-furrow mouldboard ploughs, Ransomes' Baron tandem and Baronet types of disc harrows, and Ransomes' Orwell 11-tine and International 13-tine cultivators, and Amsco self-lift disc coulter seed-drill have been found very satisfactory after extensive tests.

Ploughing and harrowing at higher than normal speeds has been found to entail no appreciable increase in fuel consumption whilst presenting the advantages of a marked saving in time and labour cost, and a somewhat better pulverising effect. It has been realised, however, that sustained operation above normal speeds will soon spell disaster to tractor and equipment, and that such a practice calls for radical changes in design. This question of higher ploughing speeds has been fully examined in America and tractor manufacturers could, no doubt, be depended upon to adopt higher speeds if they could do so with a reduction in the cost of tractor farming.

In SIND, Jenkins' Clod Crusher is very popular among the progressive zamindars and it is anticipated that a similar demand for the Cumming Winnowing Machines will arise after these useful implements have been fully demonstrated. A small type of improved (all steel) bullock cart has been designed. It has twenty-two maunds capacity and is suited to North Sind conditions. Its price is Rs. 138. A plough with an interchangeable adjustment, a mechanism for sifting cotton seed

and filling the same into bags, an all steel harrow suitable for severe field service conditions and an intercultivator costing Rs. 12 were designed during the year under report. As regards manufacture of implements, twelve bullock carts, eighteen winnowing machines and four intercultivators were manufactured during the year.

In the NORTH-WEST FRONTIER PROVINCE, the Jenkins' Clod Crusher from Sind proved one of the most useful implements so far tried. A form of Persian wheel has been made in which the gearing, which is placed in the well, consists of two level wheels. It is cheaper than the orthodox type of the Persian wheel and is more efficient. The back axle cardon shaft and gear box of a scrapped motor lorry are being successfully used as a bullock gear for working a chaff-cutter, at a cost of one-third of the price of any bullock gear on the market. The rubber tyred carts have not lived up to the reputation gained in the first year. Bursts and bulges of the tyres have been too frequent.

A census showed that one bullock out of 16 was out of action from yoke-galls. The economic loss is very serious. The Department has designed an improved yoke which involves fitting to the country yoke where it bears on the bullocks' neck a pad of cellular rubber marketed by the Dunlop Co., under the name of Dunlopillo. Half the bullocks at the Tarnab Farm have been using this yoke for a year without a single case of yoke-gall.

5. Mechanical Cultivation

IN BOMBAY, the Karnatak Agricultural and Transport Company's tractors ploughed 1,746 acres in the Southern Division to a depth of 12 ins. for the removal of *hariali* (*Cynodon Dactylon*). This deep-rooted weed is one of the greatest pests in the Karnatak, and is responsible for heavy losses to farmers in Belgaum and Dharwar districts. It is reported that an effective technique for the total eradication of the weed has now

been developed, and the organisation of local syndicates, in the Southern Division, for the undertaking of eradication work, is under consideration.

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, the Fowler steam ploughing tackle worked satisfactorily throughout the year in the reclamation of the rough farm land, ploughing 489·5 acres in 599·5 hours at a cost of Rs. 5-8-3 per acre. It was sent, in June, to Karnal for heavy ploughing.

The McCormick Deering and Lanz Bulldog tractors, which have proved satisfactory in all respects, were put to light work during the year as they are nearing the end of their service. The Vicker tractor has shown an excessive kerosine fuel consumption, and a defective lubricating pump has rendered the Marshall tractor quite unsatisfactory.

In SIND, the Agricultural Department possesses a tractor outfit consisting of one caterpillar 35 H.P. Diesel tractor (R.D. 6) with ploughing outfit. During the two years' working, the tractor has put in 4,000 working hours in spite of difficulties such as damage due to striking buried roots. It is hoped that under normal conditions the tractor outfit will work profitably at the rate fixed, *i.e.*, at Rs. 5 per acre for ploughing with the *desi* or mouldboard plough and at Rs. 3 per acre for cultivating. A detailed scheme for the purchase of two tractor outfits has been prepared.

In the HYDERABAD State, tractor ploughing was continued near Silu, District Parbhani and about 191 acres of land belonging to thirteen cultivators was ploughed during the year.

CHAPTER IX

LIVE-STOCK

1. Cattle Improvement

SYNCHRONISING as it did with the first year of the Viceroyalty of the distinguished Chairman of the Royal Commission on Agriculture, the year under review stands out as an important landmark in the history of cattle improvement in India. A movement of far reaching importance for the improvement of Indian cattle was initiated and a lead has been given in three important directions—

(i) The urgent need for the multiplication of pedigree bulls for raising the quality of existing cattle has been emphasised,

(ii) The importance of taking steps to obviate the premature slaughter of prime milch cows when they go dry in cities has been stressed, and

(iii) An enquiry has been made to ascertain the actual position regarding production and consumption of milk in important breeding tracts, with a view to provide an economic background for a sound cattle breeding policy.

Provision of pedigree bulls.—It is common knowledge that almost the very first public act performed by H. E. Lord Linlithgow in April 1936 was the presentation of three pedigree bulls for the improvement of the cattle of the Delhi Province. In emphasising the importance of cattle to Indian agriculture, His Excellency said on this occasion, " If you would help India, help the cultivator and one of the best ways to help the cultivator is to improve the breed of cattle all over the country. The cow and the working bullock carry on their patient backs the whole structure of Indian Agriculture ". Simultaneously with the presentation of these bulls an appeal was issued to persons

of wealth and standing throughout India to donate pedigree bulls or money for their purchase and maintenance. This aroused keen interest throughout the country and the response was substantial. Within a year of the appeal, in addition to a number of collective donations, as many as 1,073 individuals responded with donations of either animals or money. No fewer than 1,322 bulls were presented or promised while cash subscriptions amounted to Rs. 1,65,000, besides a special donation of Rs. 1,000 offered for the salvage of dry cows.

It was realised that the new interest and enthusiasm aroused in cattle improvement would not be sustained or bear fruit unless supplemented by the formation of some permanent organisation in each province. The advice of the Animal Husbandry Expert was sought and as a result of the suggestions made many provinces have already started cattle improvement associations and funds.

Salvage of dry cows. Again it was considered that any attempt to improve cattle would lose greatly in effectiveness unless the serious depletion of the stock of high class dams caused by the premature slaughter of dry cows in cities were prevented. As example is better than precept, His Excellency the Viceroy gave a practical lead here also by purchasing six dry cows from Calcutta and one dry buffalo from Bombay (which would otherwise have gone to the butcher) and presenting them to the Delhi *Pinjrapole*. This was accompanied by an appeal to the public to follow suit and thereby save valuable breeding material. The practical character of this step has been fully demonstrated by the fact that five of the cows have since given birth to fine healthy calves.

Village Enquiry. *Pari passu* with these activities, His Excellency suggested that an enquiry be made in important breeding tracts regarding the character of the cattle and the production and consumption of milk by cultivators. The object of the enquiry was to collect precise information for the purpose of framing a breeding policy which could be recommended in such areas in order to enable the cultivator to produce a cow

which would yield enough milk to rear a good calf and leave a sufficient margin for human consumption. The enquiry which was financed by the Imperial Council of Agricultural Research was conducted during the winter of 1936-37. The report which has been published contains a large volume of valuable information on which suitable breeding policies may be framed and the main results are summarised below.

A rapid survey was undertaken in seven breeding tracts, *viz.*, the Montgomery and Hariana tracts in the Punjab, the Kosi tract in the United Provinces, the Kankrej tract in the Bombay Presidency, the Ongole tract in the Madras Presidency and one similar area each in Bihar and the Central Provinces. Prior to starting their work the supervisors were given a course of training at Delhi. The enquiry lasted for five months.

Results. These areas with the exception of Bihar where the number is nine support on an average 6 to 7 persons per holding. The distribution of this population according to age is as follows: there is one infant under three years for every two children between 3 and 10 years of age and for every six adults over 10 years. The average area cultivated per holding varies from 6·9 acres in Bihar to 23·2 acres in the Ongole tract. In the Kankrej, Central Provinces and Montgomery tracts 21 and 22 acres per holding are cultivated while the corresponding averages in the Kosi and Hariana tracts are respectively 11·7 and 12·8 acres. Almost the whole of this area is irrigated in the Montgomery tract, 40 to 50 per cent in the Hariana and Kosi tracts, 28 per cent. in Bihar, 10 per cent. in Ongole, 5 per cent. in Kankrej and 2·5 per cent. in the Central Provinces tracts.

The average number of work-animals maintained varies from 3·74 per holding in the Montgomery tract to 1·67 in Kosi. Expressed in terms of area cultivated per bullock the figures are 12·6 acres in Kankrej area, 9·0 acres in Ongole, 6 to 7 acres in Montgomery, Hariana, Kosi and the Central Provinces and

3·6 acres in Bihar. Apparently the Bihar bullock is the least efficient and the Kankrej bullock the most efficient.

The numbers of milch animals maintained per holding vary from 4·2 and 4·1 in the Kankrej and Ongole tracts to 1·9 in Bihar. The Hariana and Kosi tracts have between 2·0 and 2·3 while the Central Provinces and Montgomery tracts maintain 3·2 and 3·1. Generally buffaloes predominate in the North and cows in the South. Considering the seven areas together the proportion of cows to buffaloes maintained on the holdings is 8 to 7. The proportion of females in milk was however 5 cows to 7 buffaloes. The percentage of the total female cattle population found to be actually in milk is 36 for cows and 59 for buffaloes but these figures are probably vitiated to some extent by seasonal influence in breeding. The proportions worked out from lengths of the milking and dry periods are 48·3 per cent. for cows and 55·5 per cent. for buffaloes.

The average daily milk yield of cows during a lactation for the seven areas was 3·74 lbs. and that for buffaloes was 7·82 lbs. For individual areas the yields of cows were between 4 and 5 lbs. in the Montgomery, Hariana and Ongole tracts, between 3 and 4 in Kosi and Kankrej, 2·74 in Bihar and 1·67 in the Central Provinces. Corresponding figures for buffaloes were 11·21 for Hariana, 8·24 for Montgomery, 7·97 for Kankrej, 7·06 for Kosi, 6·53 for Ongole and 5·5 for Bihar and the Central Provinces.

The average over-all daily yield, which may be taken as an index of milking efficiency was 1·73 lb. for cows and 3·99 lb. for buffaloes in the seven areas. Figures for individual tracts were (1) Cows: Montgomery 2·53, Ongole 2·17, Hariana 2·16, Kosi 1·74, Kankrej 1·68, Bihar 1·27 and the Central Provinces 0·66 lb. (2) Buffaloes: Hariana 5·83, Montgomery 4·43, Kosi 3·57, Ongole 3·50, Kankrej 3·29, the Central Provinces 2·34 and Bihar 2·33. It may be said generally, that buffaloes are twice as efficient as cows.

The estimated average lactation yield for the seven areas was 943 lbs. for cows and 2,160 lbs. for buffaloes. Cows

remained in milk for 8·81 months, and dry for 9·21 months, the interval between calvings being 18·2 months. Buffaloes calved at intervals of 18 months but they remained in milk for 10 months and dry for 8 months only.

The average production of milk per day per head of the human population in a holding varied from 7·85 lbs. in Bihar to 35·33 in the Ongole tract, the average for the seven areas being 23·36. The *per capita* consumption of milk and milk products, expressed in milk equivalent, amounted to 10·16 ozs. per day. The balance of 13 ozs. was mostly sold off the holdings as milk or as ghee. A small proportion was stored as ghee for future use.

The average *per capita* consumption of 10·16 ozs. was made of 5·05 ozs. of liquid milk, 0·13 oz. of ghee, 0·17 oz. of butter and 0·22 oz. of curd. In addition to the above, in ghee producing areas the skim-milk derived from the excess ghee which is sold is consumed. In the area dealt with, the average consumption of skim-milk was 8·75 ozs. per head *per diem*.

When the consumption of fluid milk was analysed it was found that the male members of the family get more than the females. The quantities of fluid milk consumed per head per day by adults, children and infants were respectively :

(1) Males : 6·63, 5·82 and 3·77 ozs.
(2) Females : 3·34, 3·77 and 2·53 ozs.

The proportion of females receiving milk was also uniformly less than that of males.

Taking individual areas the daily consumption per head of milk and milk products was : Montgomery 15·53, Hariana 12·39, Kankrej 12·07, Kosi 9·71, Ongole 8·73, the Central Provinces 6·73 and Bihar 5·51 ozs. expressed in milk equivalents.

Consumption generally increased with production up to a certain stage, whereafter it became level, the balance left over being sold. The relationship between the two factors and the stage at which increase in consumption ceases varies from area to area.

On 16 to 20 per cent. of the holdings in Kankrej, Bihar, the Central Provinces, Kosi and Montgomery no milk was produced. In Bihar and Kosi these non-producers did not consume any milk or milk products, in Montgomery and the Central Provinces ⅓ to ½ of them consumed small quantities of ghee. In the Hariana tract non-producers formed only 7 per cent. of the total holdings, while in Madras all holdings produced some milk. In both these areas everyone consumed some milk or ghee.

The village consumption of *khoa* (desiccated milk) and other indigenous products was negligible, and there was no consumption at all of condensed milk or other tinned milk foods in any of the holdings investigated.

As regards feeding of calves it was found that generally more milk is fed to the male calf than to the female, except in the Ongole tract. The reverse was the case with buffalo calves.

2. The Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry

THE second meeting of the above body was held in Madras in December 1936, by invitation of the Government of Madras. His Excellency the Governor of the Presidency was pleased to open the Conference and attended the first session which was devoted to a discussion of the better utilisation of forest areas for grazing purposes. A feature of the Conference was the presence of and participation in its proceedings by two eminent experts, *viz.*, Sir John Russell, Director, Rothamstead Agricultural Research Station, and Dr. N. C. Wright, Director of the Hannah Dairy Institute, Ayr.

On the second day the Conference broke up into committees dealing with veterinary education, animal health, animal industry, animal nutrition and dairying. The combating of such diseases as rinderpest, measures to give effect to His Excellency the Viceroy's cattle improvement scheme, the marketing of animal products such as hides and skins, and nutrition problems engaged the special attention of the full Conference. Matters

like dairy legislation and international conventions relating to the trading in live-stock products also came under scrutiny at the Conference. The decisions reached are briefly indicated below :—

(a) Castration, vaccination, etc. For carrying out castration, vaccination, and other live-stock improvement work, properly-trained stockmen working under veterinary supervision should be employed to supplement the work of the provincial veterinary departments.

(b) Revision of the forms for collecting all-India statistics. In order that they may be more useful than at present, the forms and tables for collecting all-India statistics relating to live-stock were revised.

(c) Rinderpest. The question whether goat virus alone should be used for general prophylaxis or for control of outbreaks only and, if so, what measures will be necessary in the event of the accidental appearance of the disease in such areas after a long period of immunity, were reserved for further examination. So far as the control of outbreaks is concerned, the Goat Virus or Vaccine methods may be adopted in the case of cattle. The application of these methods to buffaloes requires further research and for the present a controlling dose of serum should be used simultaneously with the virus or vaccine. All good cattle and buffaloes and improved stock should receive prophylactic treatment and India should be mapped out to show the areas in which rinderpest is enzootic.

(d) Prophylactic inoculation against Blackquarter. An officer with special knowledge of the pathogenic anaerobes affecting domestic animals should be appointed. Diagnosis of outbreaks should be carried out at provincial laboratories and confirmed by a specialist. Mapping out of enzootic areas in provinces according to the causal organism should be carried out.

(e) Incidence and control of diseases among sheep and goats awaiting exportation. It was decided to instruct Disease Investigation Officers to make further investigations in

provinces in regard to the incidence and control of diseases of sheep and goats which are important from the point of view of export. Special study of the problem at a later stage in the Central Institute was contemplated.

(f) Quarantine stations at ports. It was agreed that the note on the establishment of quarantine stations at the principal Indian ports should be considered by the Committee which dealt with the proposal for Contagious Diseases of Animals (India) Act and thereafter circulated to provinces for eliciting opinion thereon.

(g) Improvement of sheep-breeding. With a view to improving the sheep-breeding industry on a large scale, the first requisite would be to induce owners of non-migratory flocks to take up the breeding of pure-bred indigenous sheep. Provinces should maintain, as far as possible at central farms, nucleus flocks of all indigenous breeds which are of economic importance to the province. In order to popularise the scheme in districts, demonstration flocks of these breeds consisting of about fifty ewes and two rams in each group might be sent to selected breeders for breeding pure-bred stock under suitable controlled conditions. The financing of such demonstration flocks would be an object on which a portion of village uplift funds could justifiably be expended.

(h) Cattle dips. It was decided that information regarding the use of dips and the results achieved should be obtained from Military Dairy Farms, the Government Cattle Farm, Karnal, and other farms and that the Concrete Association of India should be asked to furnish information regarding the design and cost of dips and as to whether and, if so, what facilities they would be prepared to give should it be decided to provide for dips in this country on an extensive scale. It was also considered necessary to establish demonstration dips at Government cattle-breeding farms for propaganda purposes.

(i) Branding of animals. Approved cattle of the category of selected improved stock should be branded on the cheek with

a specified mark and further marking for individual identification, if necessary, should be done by tattooing the ear. If branding is to be done on the hide, it should be done on the neck.

(j) Artificial insemination. With the establishment of an Animal Genetics Institute the application of the methods of artificial insemination, which have proved so successful in other countries, should be studied.

(k) Classification of working animals. It was decided to postpone the consideration of the question of classifying working animals into light, medium and heavy, according to measurements, age, etc., until the complete cattle survey report was received from the Agricultural Marketing Adviser to the Government of India. It was decided that the annual calendar of fairs should include information about the rate of fee charged for each animal allowed into the ground of cattle fairs and markets and that the question of the licensing of brokers for recognised cattle fairs and markets should be examined.

(l) Grading of wool. A simple system of grading wool should be devised for the proper development of the wool industry. Facilities for washing sheep may be provided at sheep-shearing centres, but the report of the marketing survey should be awaited before carrying out a wool survey.

(m) Fodder crops. It was decided that the questionnaire prepared by the Animal Nutrition Committee for obtaining information about the fodder crops available for the stock of each province, preferably district by district, should be examined by a sub-committee of the Advisory Board before circulation.

(n) Equine abortion in Indian studs. Information should be collected from private and Government stud farms as to the occasions on which the disease in question appeared, the treatment from the nutritional point of view and the results obtained therefrom. The Animal Nutrition Section of the Central Institute should investigate scientifically the cause of the disease.

(o) Mineral feeding. The Animal Nutrition Section at Izatnagar should investigate the mineral requirements of dairy animals up to the fourth lactation in conditions of health. Special attention should be paid to cases of malnutrition due to mineral dificiencies. The Section should also render assistance to the provinces in this matter.

(p) Improvement of the dairy industry. The time is ripe for the formation of breed and milk-recording societies as an aid to developing the dairy industry of the country. The public should be educated in the advantages of using pedigree stock. Propaganda for this purpose can best be carried out through a central agency, and it was recommended that the necessary facilities for the purpose should be provided.

(q) Registration of animals. The Central Pedigree Herd Books should deal with eight milch breeds of cattle of all-India importance and should lay down forms, methods, rules, etc., for registration of such breeds to be followed by the provinces. The application for registration should be made to provincial organisations who after preliminary verification should pass it on to the Central organisation with recommendations. To accelerate the movement, registration in the Central Herd Books might be made free of charge for the first eighteen months. Thereafter a fee of about Rs. 2 per animal might be levied.

(r) Buffaloes in the dairy industry. The time has come for paying more attention to the development of the various breeds of buffaloes, especially the important breeds.

(s) Burdizzo castrator.—The use of the Burdizzo Castrator should be extended and villagers trained in its use under veterinary supervision.

(t) Statistics in research. The Statistician should prepare a note dealing with the elementary aspects of statistics in relation to Animal Husbandry and Veterinary problems and assist any research worker in the lay-out of any particular set of experiments. In particular, he should advise as to how far the

results likely to be obtained from such research would be amenable to statistical interpretation. The Statistician or his deputy should be employed to lecture to the post-graduate class held annually at Mukteswar.

3. Animal industry

APPENDIX XIII contains detailed figures relating to the imports and exports of live-stock and live-stock products for the five years 1932-33 to 1936-37. The following are the total values :—

Year	*Value in lakhs of rupees	
	Imports	Exports
1932-33	4,58	10,41
1933-34	4,27	13,02
1934-35	4,93	11,88
1935-36	4,03	13,63
1936-37	4,22	16,50

The export figures for the year under review show an appreciable and welcome rise under all heads, particularly hides and skins. The values of the different products for the year 1936-37 are as under :—

	Imports	Exports
	Rs.	Rs.
Live animals . .	15,67,677	8,31,468
Hides and skins—		
Raw hides .	2,33,644	1,33,38,819
Raw skins .	9,67,701	3,01,36,267
Tanned or dressed hides . .	57,938	3,17,56,941
Tanned or dressed skins . .	11,67,718	3,56,53,263
Wool . . .	2,38,24,565	3,73,89,473
Dairy products .	86,22,349	17,74,441
Other products .	57,14,518	1,40,84,179
	4,21,58,110	16,49,64,851

* The figures published this year exclude the value of finished leather goods.

The question as to whether India possesses sufficient bullock power for her requirements is raised from time to time. Full information to enable one to answer this question is not available at present, but during the year under review an attempt was made to collect all existing data on the subject. These are tabulated and included in this review as Appendix XIII.

4. Contagious diseases and their control

DETAILED figures of the reported mortality from contagious diseases for 1936-37 are given in Appendix X. Of the major cattle plagues that are responsible for this large annual loss in all parts of the country, Rinderpest and Hæmorrhagic Septicæmia account for nearly 75 per cent., as will be seen from the following summary of the position in British India for the four years from 1933-34 to 1936-37 :—

Year	Total reported mortality among bovines	Mortality from Rinderpest		Mortality from Hæmorrhagic Septicæmia		Mortality from Black-quarter		Mortality from Anthrax		Mortality from other contagious diseases	
		No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
1933-34	289,774	178,301	61·5	60,485	20·9	14,401	5·0	9,377	3·2	27,208	9·4
1934-35	216,756	118,698	54·8	43,156	19·9	10,484	4·8	5,869	2·7	38,549	17·8
1935-36	228,693	135,251	59·1	30,750	13·4	9,498	4·2	7,118	3·1	46,076	20·1
1936-37	279,397	160,055	57·3	43,456	15·6	12,863	4·6	10,478	3·8	52,545	18·9

During the year under review mortality amongst all classes of live-stock has gone up by about 66,000 over the previous year, the figures for the two years 1935-36 and 1936-37 being 2,52,000 and 3,18,000 respectively. The following statement shows the rise or fall in the total mortality as well as in the mortality due to Rinderpest in the various provinces of British

India during the year under review as compared with the previous year :—

Name of province	Increase or decrease (in thousands) in mortality over 1935-36	
	Total reported mortality (all contagious diseases)	Total reported mortality from Rinderpest
Madras	+10·0	+2·4
Bombay	+10·7	+8·7
Bengal	+6·6	-11·0
United Provinces . . .	+9·0	+2·4
Punjab	+1·5	-0·5
Burma	-1·2	+2·5
Bihar and Orissa . . .	+11·4	+4·1
Central Provinces . . .	-2·3	+0·9
Assam	+9·2	+7·0
North-West Frontier Province	+0·6	-0·2
Sind	+5·5	+4·5
Baluchistan	+6·6	...
Total increase .	66·5	20·8

The largest increase in the total mortality was reported from Bihar and Orissa, the figure being 11,400; next come Bombay and Madras with 10,700 and 10,000 respectively, and then the United Provinces and Assam with 9,000 each. According to the 1935-36 returns there were practically no deaths in Baluchistan, while in the year under review the reported figure is 6,600. This conspicuous difference coincides with the serious dislocation of work effected by the earthquake, as a consequence of which reporting was probably rendered impossible in 1935-36.

It will be seen from the above statement that Rinderpest alone was responsible for nearly one-third of the total excess in mortality, and the largest increase of 8,700 over the previous years figures is reported from Bombay. In Assam this epizootic accounted for an increase of 7,000. Although there is a considerable increase in total mortality in Bengal the figures of

Rinderpest from that province reveal a striking decrease of 11,000. This is attributed to the use on a large scale during the past few years of the " goat virus alone method " of vaccination, which is now in common use in most provinces and states, but it will be observed from the above tables that taking India as a whole, the control of Rinderpest is still the most important disease problem, for the toll levied every year by this epizootic is more than 50 per cent. of the total mortality reported from all contagious diseases. The proportion of deaths due to Rinderpest has steadily fallen of late and the position has considerably improved during recent years but the annual figures from the provinces are still disconcerting, particularly when it is remembered that an efficient and cheap method of prophylaxis is now available.

During the year under report the number of preventive inoculations against contagious diseases increased from 3·1 to 4·4 millions and of this total 2·3 millions or about 52 per cent. were against Rinderpest. These 2·3 millions were distributed among the different methods as under :—

	Figures in thousands.
(i) Serum alone . . .	96 or 4 per cent.
(ii) Serum simultaneous . .	140 or 6 ,,
(iii) Goat vaccines . . .	2,052 or 90 ,,

The above figures are self-explanatory and reveal the increasing use and popularity of goat vaccines. The serum alone method, which confers a transitory immunity of about nine days only, is now seldom adopted and during the year under review the total number of inoculations performed by this method was 96,000 as against 474,000 in the previous year. The increase in the number of vaccinations against Rinderpest with goat virus alone from 1·3 to 2·1 millions between 1935-36 and 1936-37 is a noteworthy achievement, for every animal efficiently inoculated by this method may be considered as protected against Rinderpest for a number of years, if not for life.

Complete figures of mortality among inoculated animals are not available but such figures as could be obtained show that

the comparatively large proportion of deaths in the case of goat tissue vaccine, namely, 6·7 per thousand, reported last year, has decreased during the year under report to 4·5 per thousand. This decrease is probably due to the greater caution now exercised, during outbreaks, in dealing with in " contact " animals which may be in the incubative stage of the disease and also to a better appreciation of the severe reaction sometimes produced in buffaloes by the use of goat virus alone.

In MADRAS an unfavourable rise in the incidence of Rinderpest was recorded during the year under report and the mortality rose to 5,102 as against 2,752 in the previous year. From the records of the past 40 years it has been found that this disease appears in regular waves at intervals of 10 years, the last peak having been reached in the year 1928-29. If the rise in the incidence now shown indicates the beginning of the next wave, the position may be considered satisfactory as the mortality recorded in 1926-27 was as high as 23,676. The seasonal migrations of cattle from and to the grazing areas and the collection of large numbers at cattle fairs have been definitely traced as the cause of dissemination of the disease. The routes and places in each district where different herds mingle have been located and steps are being taken to try and prevent the spread of the disease through such migrations.

The diseases of sheep, goats and poultry were reported for the first time during the year under report. It is expected that with further experience in the identification of diseases of these animals and poultry, an improvement in the reporting of such outbreaks will be noticed. Cases of Sheep Pox, Anthrax, Hæmorrhagic Septicæmia in sheep and Pleuropneumonia in goats were reported during the year.

In all 79,273 head of cattle were attacked by contagious diseases in BOMBAY and of these 34,542 died. Corresponding figures for the previous year were 88,917 and 23,875 respectively. The increase in mortality is attributed to the very wide-spread outbreaks of Rinderpest which alone swept away

20,725 animals. The reported mortality due to Anthrax, Sheep Pox, and Bovine Surra was 530, 330 and 17 respectively.

As usual, fees were charged for protective inoculations and vaccinations except in the case of Rinderpest. The total number of vaccinations carried out by goat tissue virus alone method in face of outbreaks was 163,276 and in addition 87,378 head of cattle were protected in clean areas with an insignificant resultant mortality of only 14.

As reported in the previous years the diseases of poultry claimed more attention from the Civil Veterinary Department and the chief epizootics during the year were Doyle's (Ranikhet) disease, Fowl Cholera and Fowl Pox. The total mortality recorded due to these contagious diseases and other ailments of poultry was 6,288.

In September last the Bombay Government issued orders that all premium bulls, gift bulls and village poultry should be protected free of charge against all contagious diseases. The question of protecting all animals free of charge against all contagious diseases is at present under the consideration of Government and if free inoculations and vaccinations are allowed, cattle owners will be better able to have their stock actively immunized against such seasonal diseases as Hæmorrhagic Septicæmia and Blackquarter in those areas in which they are enzootic.

In BENGAL, the total mortality reported for contagious diseases during the year was 52,702, as against 43,240 during the previous year, and was the maximum for the quinquennium. The loss from Rinderpest showed an appreciable decline but this has been nearly balanced by deaths among goats, amounting to 12,714, due to parasitic diarrhœa, a disease which has not previously appeared as an enzootic. There was an increase under Bovine Anthrax and Hæmorrhagic Septicæmia. Rinderpest was wide-spread throughout the province and no district was free from it. The decrease in the number of deaths from this disease, in spite of its wide distribution in the presidency,

may be taken as due to the efficiency of control by goat tissue vaccine, which alone was used to control all outbreaks. This method of protection is now popular amongst cattle owners as it has been invariably noticed that animals once protected do not contract the disease during a subsequent outbreak. During the period under review 292,656 animals were protected by goat tissue vaccine as against 368,313 in the preceding year.

Live-stock epidemics were more severe in the UNITED PROVINCES during the year under review and Rinderpest and Hæmorrhagic Septicæmia were responsible for the increase in mortality figures. The total reported mortality was 56,779 as against 29,332 in the previous year. Rinderpest was prevalent in practically every district and the total number of inoculations with goat tissue vaccine was 202,148 as against 134,555 during the previous year. Hæmorrhagic Septicæmia was responsible for 12,248 deaths as against 6,315 in the preceding year.

Progress was maintained in the treatment of Surra and 2,059 cases were treated as compared with 1,349 and 329 in 1935-36 and 1934-35 respectively. The incidence was widespread and the disease was reported from 22 districts. The report indicates that the incidence of bovine Surra is more prevalent than has hitherto been suspected. The number of deaths reported during the year under review was 200, and when treatment was carried out it is reported to have been fairly satisfactory.

A special tract was selected in one district for the introduction of a scheme for the control of live-stock epizootics and this furnished valuable information in regard to their spread and is said to have fully justified the additional staff sanctioned for the purpose. Rinderpest demanded most attention and 25,870 animals were immunized in this area as against 6,743 in the previous year.

In the PUNJAB, the year was dry and, on the whole, a healthy one for live-stock, the total mortality from contagious diseases

being 31,063 as against 29,472 in the preceding year. Hæmorrhagic Septicæmia levied a heavy toll and was responsible for as much as 63 per cent of the total mortality. Next in importance was Rinderpest and outbreaks were fairly extensive in certain areas.

The number of cases treated at 46 Surra centres was 3,762 as against 3,673 during the preceding year. The number of animals vaccinated in the course of outbreaks of Rinderpest with goat tissue virus was 169,116 as against 92,065 in the preceding year. Serum and vaccine inoculations against Hæmorrhagic Septicæmia were 71,235 and 537,789 respectively as compared with 56,477 and 385,582 during the previous year.

In the CENTRAL PROVINCES AND BERAR the mortality due to Rinderpest was 8,608 as against 5,696 during the previous year. The number of goat virus vaccinations performed during the year was 492,730. In addition to this 47,519 head of cattle were protected by the serum simultaneous method. The staff provided under the scheme financed by the Imperial Council of Agricultural Research vaccinated 141,177 as against 117,115 head of cattle during the preceding year. An increase in mortality due to Hæmorrhagic Septicæmia is reported, the deaths being 5,211 as against 3,209 in the last year.

Surra in bovines was wide-spread in the province, the total number of cases confirmed in the year under report being 114.

Contagious diseases were wide-spread in the province of BIHAR and the number of deaths increased by about 10,000 over the figures reported for the preceding year. The increase was partly due to greater virulence of attacks of Rinderpest and Hæmorrhagic Septicæmia and also to a larger number of deaths recorded under a new head " other causes ". The total mortality due to Rinderpest was 7,918 as compared with 5,639 reported in the previous year. Protection by goat tissue virus method was given in all the districts and 348,087 animals were immunized as compared with 260,965 immunized during the previous year.

Cases of bovine Surra were reported from seven districts and this infection was responsible for 86 deaths in buffaloes.

In BURMA, the mortality from Rinderpest was 31,071 as compared with 28,509 during the preceding year. Extended use of desiccated spleen vaccine in the control of Rinderpest is reported and it is stated that this vaccine gave efficient protection from the third day onwards and was used with considerable success, not only in the outbreak areas but also in the adjoining clean areas with a view to form a belt of immune cattle round the area of outbreak. During the year 364,789 cattle and buffaloes were immunized with this vaccine as against 14,146 during the previous year. Mortality from Anthrax has decreased, the figure recorded being 690 as against 929 in the preceding year. This decrease is attributed to the use of the spore vaccine method of control. A decrease in mortality due to Hæmorrhagic Septicæmia is also recorded, the figures for 1935-36 and 1936-37 being 8,254 and 3,937 respectively. Surra was responsible for 115 deaths as compared with 83 reported during the preceding year.

In the NIZAM'S DOMINIONS, the toll levied by contagious diseases was 13,359 as against 13,417 in the preceding year. The total number of outbreaks reported during the year was 1,257 and of these Rinderpest, Hæmorrhagic Septicæmia and Blackquarter accounted for 3,834, 5,916 and 1,894 deaths respectively. Surra was responsible for 110 deaths in bovines and mortality due to Anthrax in cattle and buffaloes was 231 and 97 respectively. The total number of inoculations against contagious diseases was 335,475 as against 271,896 in the previous year. During the year under review Fowl Pox vaccine was introduced in the field for the first time and altogether 307 birds were vaccinated against this disease.

Rinderpest broke out in the MYSORE STATE after a lapse of some years and 124 outbreaks were registered during the year under review. As a result of investigation the source of infection was attributed to some infected herds of buffaloes driven

for sale by cattle dealers from British Indian provinces through villages in the MYSORE STATE. Altogether 38,520 animals were protected by goat virus alone method and 1,290 by the serum simultaneous method. Severe outbreaks of Anthrax were reported during the year and 1,414 outbreaks were registered. The number of animals protected against Anthrax during the year was 19,992 as against 18,886 during the previous year. Hæmorrhagic Septicæmia and Blackquarter were also responsible for a mortality of 1,190 and 3,281 respectively and the number of inoculations performed against these diseases was 30,356 and 88,095 respectively. The total number of outbreaks of Sheep Pox registered during the year was 226 and 41,115 sheep were protected with vaccine as against 24,431 in the previous year.

5. Treatment of non-contagious diseases, public health work, etc.

DURING the year under report there was an increase in the number of hospitals and dispensaries and in the activities of veterinary staffs in regard to local diseases and public health. Detailed figures are given in Appendix X. The following comparative statement regarding the position in British India for the last three years will show the steady increase in the total number of hospitals and dispensaries and also in the number of cases treated :—

	1934-35	1935-36	1936-37
Number of hospitals and dispensaries .	1,059	1,086	1,111
Number of cases treated at hospitals and dispensaries . .	3,008,571	3,476,739	3,873,968
Number of cases treated on tour . .	1,969,869	2,283,127	2,189,425

Among other activities of the Civil Veterinary Departments, the most important is propaganda work. This consisted of (*a*) issue of pamphlets in the local vernaculars regarding common

diseases and their control, hygiene, breeding, first-aid treatment, etc., (*b*) lectures at agricultural schools, rural development classes, etc. and (*c*) attending fairs and shows and running veterinary sections in exhibitions. Other work includes meat inspection, investigations of cases of criminal poisoning and treatment of cases convicted under the act for the prevention of cruelty to animals.

During the period under review, inspection of sheep and goats intended for export to Ceylon was undertaken in the MADRAS PRESIDENCY and the total number of sheep and goats certified for export during the year was 27,662 as against 32,341 of the previous year. The fall is ascribed to the fact that, from the 1st February 1936 the number of animals to be exported was restricted by the Ceylon Government to 1,988 per mensem.

In BENGAL, several important and interesting charts, models, specimens, etc., were exhibited in the District Industrial and Agricultural Exhibitions and lectures were delivered regarding care, management and treatment of cattle and other animals, diseases communicable from animals to human beings and methods of prevention. Leaflets and pamphlets were also distributed in this connection.

The system of providing treatment in outlying villages by means of weekly dispensaries has been in vogue in the Punjab for the last ten years. The number of such dispensaries in the year under review was 1,200. This system has proved very helpful as it brings treatment facilities within easy reach of a much larger number of animals. A scheme for veterinary first-aid centre under co-operative societies, which has proved a success in certain districts, is being extended to other districts in the province. The system of opening outlying weekly dispensaries in villages has also been taken up in the NORTH-WEST FRONTIER PROVINCE and the CENTRAL PROVINCES and it is reported that it is working very satisfactorily and the facilities provided are much appreciated.

6. Breeding Operations

(a) Cattle. The significance of the oft-repeated statement " The bull is half the herd " is more appreciated every year and along with the recognition of this fact the simultaneous interest and activity evinced all over India in the elimination of scrub bulls by castration is paving the way for the much needed improvement of live-stock in this country. In a vast country like India, the absence of herd books, registration, milk recording and other modern agencies for effecting and measuring improvement makes it difficult to assess, with any degree of accuracy, the progress achieved from year to year. The best index therefore, under these circumstances, is probably afforded by two activities of Government departments, namely, (i) the number of approved bulls at stud and (ii) the elimination of undesirable male stock by castration. Detailed figures relating to these were presented in the preceding review and it was observed that, though slow, steady improvement has taken place during the last six years in regard to both these activities.

The year under review marks a substantial increase in the number of approved bulls in different provinces due to H. E. the Viceroy's appeal referred to in a previous section. Satisfactory as this increase is, the total number available is still grossly inadequate, there being about 11,000 approved bulls although there are 39 million cows in British India. The number of approved bulls thus forms only about 1 per cent of the total calculated number of sires, the remainder being of very variable and unknown quality. As regards castration (*vide* Appendix X), an increase of about 10 per cent has been recorded over the figure reported last year, the total number for the two years being 1,170 and 1,276 thousands respectively. This works out to roughly 25 castrations per thousand male population. These *pro rata* figures indicate the tremendous leeway yet remaining to be made up.

At the Hissar Farm in the PUNJAB, the total rainfall during the year under review was 11·29 inches only and the monsoon

rains on which the farm depends so much for grazing was negligible. The year thus was one of grave anxiety and meant hard work for the fodder section of the Farm. The total number of stock issued during the year was 1,429 as against 1,385 in the previous year. The demand for pedigree bulls continued to be keen and the Farm was unable to cope with all the indents. Seven hundred and eleven bulls were issued as compared with 616 in the previous year. This number creates a new record for the Farm. Two bulls were supplied to H. E. the Viceroy for presentation to Delhi Province and 26 to the District Board, Delhi. The total book value of the bulls issued was Rs. 2,58,560 as against Rs. 2,44,485 in the previous year. Against this a sum amounting to Rs. 67,300 was realised from District Boards, so that the direct contribution of the local Government for the development of cattle breeding was Rs. 1,91,260. The selection of the best milkers and the building up of a milch herd of Hissar cows without detriment to the working qualities of the male stock continued as usual. In the Hariana tract there were 2,281 pedigree bulls at stud as compared with 2,255 in the previous year. The total number of approved bulls at stud was 5,370 as compared with 5,033 in the previous year. In addition there were 5,203 privately owned registered bulls working under departmental supervision. In the Dhanni tract there were 87 District Board and 269 subsidy bulls working under the Dhanni Cattle Breeding Scheme as compared with 91 District Board and 232 subsidy bulls in the previous year. It is stated that this breed of cattle is steadily gaining in popularity. During the year the system of registration of stock in the tract was over-hauled and improved upon. More stress is now being laid on the breeding records of individual animals and in all fairs and shows it is being insisted upon that owners competing for prizes shall produce covering and pedigree certificates for their animals. Intensive breeding operations were also continued under departmental supervision in the selected areas where pedigree bulls from Hissar and Grantee Farms are

located. These tracts are now supplying high class stock to the Punjab as well as to other provinces notably the United Provinces. A number of other breeding schemes were also in operation in parts of Montgomery, Dera Ghazi Khan and other districts for the Malvi, Sahiwal and Dhanni breeds.

In regard to the improvement of buffaloes, 1,270 buffalo bulls were registered this year as against 1,127 in the previous year. The total number of approved buffalo bulls under departmental supervision, including the bulls belonging to local bodies, at the end of the year was 2,629 as compared with 2,516 during the previous year. The following working programme for the development of buffalo breeding is to be followed in the Department in suitable areas :—

(*a*) to increase high class buffalo bulls particularly in the well known buffalo-breeding tracts, so that the majority of villages may have one or more approved buffalo bulls under departmental supervision,

(*b*) to organise Civil Veterinary Department breeding societies around each buffalo bull,

(*c*) to organise one-day village shows in selected areas; and

(*d*) to finance the above measures to start with by funds provided by district boards and Government on an equal basis.

In the NORTH-WEST FRONTIER PROVINCE, there were 228 Dhanni bulls under the subsidy scheme during the period under review. It is stated that in certain tracts of the province which are fertile enough to provide for their maintenance this breed is rapidly gaining popularity and castration of scrub bulls is being pushed ahead.

In BIHAR, a provincial and also District Cattle Improvement Associations were formed during the year under review. After the separation of Orissa the total number of stud bulls maintained at district veterinary hospitals was 31. A pedigree herd of Tharparkar cattle was maintained at Ranchi. The

Phulwari Farm issued three Tharparkar bulls for stud purposes, but the general cattle-breeding policy of the province was still under consideration during the year.

In MADRAS, the number of live-stock at the Hosur Cattle Farm was 697 as against 634 in the previous year. Four important herds, *viz.*, Cross-bred, Sindhi, Kangayam and Hallikar, were mantained at the Station, while a small Ongole herd and a few buffaloes were located at Guntur.

In BOMBAY, the rearing, selection and distribution of premium bulls in selected cattle breeding tracts of the presidency continued to be the major contribution of the live-stock section to cattle improvement and there were 247 premium bulls in different divisions during the year under report. The response to H. E. the Viceroy's gift bull scheme amounted to approximately Rs. 61,000 in cash and in addition there were 496 offers of stud bulls. The number of gift bulls issued during the year under report was 90 and these animals were stationed at suitable centres in the districts. An intensive enquiry in the buffalo breeding tracts of the Presidency has indicated that considerable deterioration is taking place in the buffalo population and that the cultivators are getting lower returns from these dairy animals. A scheme which is now in operation provides for the testing of a large number of cultivators' buffaloes for milk and butter fat yield over a period of time and for the selection of young male stock from the best milkers for rearing and subsequent issue for breeding purposes. In all, 1,037 animals of the three main buffalo breeds of the Presidency have been tested and 52 good male buffaloes, the progeny of high yielding dams, were selected for rearing and breeding purposes with a view to using them for the grading up of local animals. The scheme was in operation in 36 selected villages. It was originally financed from the rural uplift scheme but the cost is now met from the budget grant of the Live-stock Section. The registration of pedigree stock of the Khillari, Gir, Kankrej and Amrit Mahal breeds was not quite so brisk during the

period under report but this is due to the fact that considerable ground had already been covered and it is only new births and those young animals overlooked before that are now available for registration. The total number of pure bred stock registered up to July, 1937 was 2,570. In addition to the above activities co-operation with the *Gowrakshak Mandali*, Khandivalli, in the breeding of improved Gir cattle is being continued. The *Mandali* has a good herd of pure Gir cattle of over 250 head and during the year five bulls were issued for breeding purposes. Attention is given particularly to breeding for early maturity and high productivity and to a scientific investigation into the nutritive value of different feeding stuffs. Herd registers of pure breeds in the presidency are being maintained in the interests of local breeders.

In BENGAL, 1,000 pure Hariana bulls were purchased during the year from funds allotted by the Government of India and 100 bulls were distributed to each of the ten selected districts where improvement work has been actively started. Already 14,000 scrub bulls have been castrated in these districts and with a distribution of improved bulls a definite beginning has been made to improve the live-stock in these areas. It is hoped that the remaining districts will be able to participate in the coming season from the second instalment of the Government of India grant. District Boards have helped in the cost of distribution, etc., by suitable grants. The whole idea behind the improvement scheme is to develop the keeping of better stock by (*a*) propaganda, (*b*) the castration of scrub bulls, (*c*) encouraging the growing of more fodder crops, (*d*) selecting the best males for stud, (*e*) the better feeding of all good animals, (*f*) keeping only the number of animals that can be maintained properly and (*g*) the better care and handling of animals.

In ASSAM, the vigorous measures for the eradication of Johne's disease referred to in the previous year's review continued during the year under report. No sales or issues of

affected animals were permitted. Cattle improvement work on the same lines as in the previous year was continued in the north Goalpara forest reserve and in certain notified provincial grazing reserves and village breeding areas. During the year under report sanction was accorded for use of Rs. 65,000, out of the rural uplift grant made by the Government of India, for the improvement of the live-stock of the province. An arrangement has been made for the maintenance of 14 groups of bulls in selected areas in all the plain districts. Approval for a grant of Rs. 15,000 for the Live-stock Improvement Association of Assam has also been obtained. In response to H. E. the Viceroy's appeal 249 bulls were offered and these animals were distributed to the sub-divisional branches from which they came. In the Central Provinces, 289 bulls were provided from the funds collected by public donations in response to H. E. the Viceroy's appeal and also from the Government of India grant.

In MYSORE, pedigree stock registers were introduced and it is hoped that this procedure will be helpful in arousing interest in pedigree breeding. A survey of valuable stud bulls has also been made and it has been noted that 738 Hallikar stud bulls and 97 Amrit Mahal bulls are available for service in the State. In HYDERABAD, two breeds of cattle are maintained, namely, Malvi for the north-eastern part of the State and Krishnavalley for the south-eastern districts. In the remaining part of the State, which is the heavy black soil area, efforts are being made to popularise the Deoni breed. At the end of the year the number of breeding bulls on the register of the Civil Veterinary Department was 33. In TRAVANCORE, bulls were stationed one in each of the five wards of the Trivandrum Municipality. In addition to these two more bulls were stationed in veterinary hospitals at Trivandrum and Kottayam. With a view to encourage private individuals to maintain good stud bulls to serve their cows the Department has been giving annually a number of monetary grants. The grantee is permitted to levy a fee for

the service of the bull and is required to maintain a proper register of services. On the recommendation of the Board of Agriculture this number has been increased to 30 as compared with 15 during the previous year. In BARODA, considerable interest is being evinced in the improvement of veterinary and animal husbandry activities and a number of co-operatively owned breeding herds have been started during the year under review. The *pinjrapoles* were approached with a view to induce them to co-operate with the department in live-stock work.

In BALUCHISTAN, two Tharparkar and three Nari breed bulls were issued for the improvement of cattle in the various sub-divisions. A scheme was also sanctioned for the improvement of cattle breeding in Baluchistan and 20 bulls were purchased with a view to start controlled cattle breeding work in various areas. In COORG, a scheme for the improvement of cattle has been launched during the year under review and some Sindhi bulls and Murrah buffalo bulls were purchased with a view to distribute them for stud purposes in suitable localities.

Pedigree Herd Books. Mention was made in the previous year's review of the decision of the Imperial Council of Agricultural Research to initiate and maintain herd books for the breeds of milch cattle of all-India importance. The breeds selected were :—

(*a*) *Cattle.* Sahiwal, Sindhi, Tharparkar, Hariana, Ongole, Gir and Kankrej.

(*b*) *Buffaloes.* Murrah.

As an authoritative definition of breed characteristics is an essential preliminary to the establishment of Herd Books, a convener was appointed for each of these breeds who would call meeting of important breeders to decide on the definitions to be adopted. The conveners started work during the year and as soon as their reports are received, a brochure defining the characteristics of each breed will be issued by the Imperial Council of Agricultural Research for the guidance of breeders and others interested in these breeds.

(b) Other animals. During the year under review, the Goat-breeding Farm at Etah, which is maintained from a grant made by the Imperial Council of Agricultural Research, continued to do useful work. Eighty-five goats completed their lactation during the year and the average daily yield during lactation was 2 lbs. 4 oz. as against 2 lbs. 5 oz. in the previous year. Though there is a slight decrease in this respect it should be pointed out that the dry period has decreased to 72 days from 108 in the preceding year. The highest yields recorded during the year were as under :—

Jumnaparis	572 lbs. in 209 days.
Desis	682 lbs. in 252 days.
Barbaris	536 lbs. in 197 days.

Certain interesting figures are available regarding the milk production of dams and daughters of the two breeds, namely, Jumnapari and Barbari, which illustrate the improvement effected by systematic breeding and management. The average daily yields of Jumnapari dams and daughters during lactation were 1 lb. 6 oz. and 2 lbs. 1 oz. respectively. The corresponding figures for Barbaris were 1 lb. 7 oz. and 2 lbs. These figures show an improvement of 50 per cent in Jumnaparis and about 40 per cent in Barbaris as regards daily milk production. It may be added that the lactation periods have decreased from 262 to 185 days in Jumnaparis and from 211 to 172 in Barbaris. Dry periods have also decreased in the two breeds by 36 and 89 days. This shows that not only has milk production increased but the kidding interval has also decreased appreciably.

At the Hissar Farm, PUNJAB, the milk yield of Jumnapari goats shows that steady progress is being maintained in building up a good milking strain. The highest yielder of the year was in her seventh lactation giving 977 lbs. of milk in 257 days with a maximum daily yield of 5½ lbs.

Work in connection with the improvement of the famous Bikanir breed of indigenous sheep has also been taken up in the Punjab under a grant sanctioned by the Imperial Council

of Agricultural Research. The experience already gained in the sheep breeding section proves conclusively that indigenous breeds of sheep respond very markedly to a higher standard of nutrition. The comparative yields of wool from the Hissar-dale and the Bikanir flock have remained almost the same as reported last year, namely 5½ seers for the rams and 3 to 3½ seers for the ewes. A keen demand for Hissar sheep continues in the districts and 48 Hissar sheep were supplied to Kangra district from the Hissar Farm at concession rates.

In BOMBAY, a sheep breeding scheme with funds provided by the Council has recently commenced work. At Hosur in the MADRAS PRESIDENCY, there were 123 sheep of the Bellary breed and the yield of the best ram was 5·2 lbs. and that of the best ewe 4 lbs. In the NORTH-WEST FRONTIER PROVINCE, the Veterinary Department maintained Pusht-i-Koh and Hissar-dale rams, and ewes for the improvement of sheep in that province; the number of rams at service being 24 during the year under report. The cross between local Hushtnagari fat-tailed sheep and rams from Pusht-i-Koh is doing well. The average live-weight has increased from 50 lbs. to 90 lbs. in the ewes and 150 lbs. to 240 lbs. for rams. Half-bred merino rams were distributed in MYSORE for the improvement of the local breed of sheep. The Bikanir sheep which comes from a country with a rainfall of some 15 inches per year has thriven well in Assam where the rainfall is over 100 inches per year. The wool yields for rams, ewes and lambs were 6 lbs., 4·4 lbs. and 5 lbs. respectively.

Attention was given to horse, mule and donkey breeding in some provinces. In the PUNJAB, the number of horse and pony stallions in non-selected districts of the province was 80 as compared with 78 in the preceding year. The number of donkey stallions was 80 as against 86 in the previous year. During the year 12 donkey stallions were issued to non-selected districts and to the Army Remount Department. Breeding societies are being formed around each of the pony and donkey stallions for the purpose of establishing a closer liaison with the Veterinary

Assistant in charge of the stallions and the owners of the mares. This system is being extended to embrace all kinds of pedigree male stock. In the NORTH-WEST FRONTIER PROVINCE, there were 12 horse, one pony and 12 donkey stallions, at stud in non-selected districts of the province. In HYDERABAD, the number of stallions at stand remained the same as in the previous year and an increase has been recorded in the total number of coverings during the year under report. In the UNITED PROVINCES, during the year 48 horse and 9 donkey stallions were at work and the total number of coverings performed was 1,870. The progeny of Government stallions continued to show improvement and some good stock was exhibited in the United Provinces Agricultural and Industrial Exhibition and other horse shows in the districts.

(c) Poultry. In the PUNJAB, the principal work of the Poultry Expert, as in past years, was directed to the evolution of improved egg laying strains of the *desi* poultry. Foreign breeds were also kept to meet the definite demand which exists for eggs for hatching purposes. Work is being carried out on two strains of *desi* fowls and an improvement has been effected in body-weight and egg production. Difficulty has however been experienced in establishing a fast colour in one of these strains, though a satisfactory result is likely to be obtained in the case of the other. During the last two years much better hatching results have been obtained by the old fashioned method of hen hatching than by the more modern method of hatching by incubators. The latter gave a hatching percentage of 38 only as against 54 in the case of hatching by hens. As a result the use of patent incubators has been practically discontinued.

In BOMBAY, a scheme for research work in poultry breeding has been started under a grant sanctioned by the Imperial Council of Agricultural Research and to which a contribution is being made by the local Government as well. This scheme which will be in operation for five years has been started at three centres. Pens of White Leghorn, Rhode Island Red, Black Minorcas and Light Sussex poultry and Indian Runner and

Khaki Campbell ducks have been established as foundation stock for breeding experiments, and it is intended to add two indigenous breeds, namely, Chittagong and the Naked Neck, to the stock. Selection is being done on the basis of trap records and feeding experiments are also in progress. Special attention is being given to the design of a suitable cheap poultry house for use in the villages. During the year under report 710 cocks of White Leghorn, Rhode Island Red and Australorp breeds were distributed in the villages and in addition premia were granted to approved poultry farmers who are co-operating in the work of poultry improvement. During the year the average number of eggs per hen on the basis of nine months' record was 165·11 for heavy breeds and 161·5 for light breeds.

In BENGAL, the cross-bred birds continued to be good layers, the average laying being 125 eggs in the year. The size of the egg is larger than that of pure Rhode Island Red and the average weight of each egg is stated to be about 2 oz. The cross-bred is a good table bird and an active forager. One cross-bred bird laid 246 eggs. In MADRAS, several exotic breeds are maintained at the Hosur Cattle Farm and agricultural stations. The maximum individual yield of White Leghorn Hens was 248, Rhode Island Reds 269 and Black Minorcas 220. The maxima of others were below 200. The percentage of hatchability came to 57·61. In MYSORE, White Leghorn fowls and eggs were distributed in selected villages. This distribution together with the measures for improvement in sheep formed the important items in the rural reconstruction scheme for model villages.

(d) Apiculture. In the PUNJAB, progress is being maintained in regard to bee-keeping and the assistant sent abroad for training has returned. Apiculture is becoming increasingly popular in MADRAS and as a result of intensive propaganda throughout the Presidency 1,614 bee hives were maintained in different centres and about half this number were located in the Coimbatore Circle. In TRAVANCORE, the apiculture branch

of the Agricultural Department has been instrumental in introducing bee-keeping in several villages in the State. It is proving a useful occupation and is being supported as a subsidiary cottage industry by the State. During the year under report 70 new apiaries were started and 36 hives, 9 smokers, 18 honey extractors and 56 escapes were manufactured and sold to local residents.

7. Dairying

THE year was marked by the greater interest manifested by the Indian public in dairying, an interest that was reflected by the numerous enquiries received by the Imperial Dairy Expert. The keenness shown by Indian States in the improvement of dairying in their areas is particularly noticeable.

The systematic development of the Sindhi and Gir breeds by the Imperial Dairy Expert and of the Sahiwal breed by the Imperial Agriculturist was continued. The average lactation yields during the year were 3,047 lbs. and 2,653 lbs. for the Sindhi and Gir herds respectively. Selective breeding in a herd of Murrah buffaloes has also been started at Bangalore. During the year the average lactation yields of purchased and farm-bred buffaloes were respectively 4,530 and 4,663 lbs. At Bangalore the best lactations during the year were:—

Sindhi	4,052 lbs. in 359 days.
Gir	6,290 lbs. in 342 days.
Murrah	5,238 lbs. in 349 days.

The pedigree Sahiwal herd at the Imperial Agricultural Research Institute, New Delhi, continued to do well. During the year the average daily yield amounted to 20·7 lbs. milk and the best cow yielded 10,119 lbs. in a lactation of 306 days completed during the year.

At KARNAL, the pedigree Tharparkar herd under the Imperial Agriculturist continued to show improvement. The average lactation yield obtained during the year was 4,422 lbs. milk in 276 days. The best lactation of the year was 9,655 lbs. in 305 days.

At the Hosur Cattle Farm in the MADRAS PRESIDENCY, four herds, namely, Cross-bred, Sindhi, Kangayam and Hallikar, continued to be maintained. In the Sindhi herd 42 cows yielded over 4,200 lbs. in a lactation and 11 between 5,000 and 7,000 lbs. Twelve Kangayam cows yielded between 3,000 and 4,000 lbs. of milk. Three of the best cross-bred cows yielded between 9,000 lbs. and 10,500 lbs.

In the BOMBAY PRESIDENCY, the Palghar Dairy District Scheme attracted considerable attention and numerous applications were received for grants of land. Two areas of 500 and 537 acres have already been allotted and efforts are being made to see that grantees observe the conditions of the grant satisfactorily.

Certain enquiries held during the year showed that the buffaloes of the Presidency are deteriorating and that they are fast becoming uneconomic producers of milk and butter fat. As has already been referred to in the previous section on Breeding, a scheme has been brought into operation for testing a large number of cultivators' buffaloes for milk and butter-fat yield and for the selection of young male stock from the best milkers for subsequent breeding purposes; 1,037 animals were tested and 52 bull calves selected during the year. The scheme was in operation in 36 villages.

In the PUNJAB, the pedigree Sahiwal herd maintained at the Lyallpur Farm continued to progress satisfactorily. The best milker gave 11,030 lbs. in 429 days, with a dry period of 65 days. Thirteen cows yielded between 5,000 lbs. and 10,000 lbs.

At the Hissar Farm milk recording with selected Hariana cows was continued for the purpose of building up a milch herd. 162 cows yielded more than 1,000 lbs. milk in the lactations completed during the year. Out of these, 28 yielded over 3,000 lbs. and 2 over 5,000 lbs. Among the heifers lactations up to 4,138 lbs. of milk in 295 days have been recorded, showing that there is some promising material for future selection.

The Grantee Farms of the Punjab now contain a considerable number of good milch cows of the Montgomery breed. At the Jahangirabad Farm 15 cows yielded over 8,000 lbs. in a lactation. In the three Farms: Montgomery, Jahangirabad and Allahdad, 18 cows yielded between 7,000 and 8,000 lbs., 43 between 6,000 and 7,000 lbs. and 81 between 5,000 and 6,000 lbs.

In the Telinkheri Dairy Farm in the CENTRAL PROVINCES, 27 Sahiwal cows completed their lactations during the year yielding 4,137 lbs. milk on the average. The buffalo herd averaged 3,526 lbs.

An attempt was made during the year by the Animal Husbandry Bureau of the Imperial Council of Agricultural Research to collect the records of the highest yielders among the cows maintained at the more important dairy farms in India. These figures are very interesting and illustrate the potentialities which Indian cattle possess for milk production. Owing to the wide variations in the conditions of climate, feeding and management, which obtain at different farms, a strict comparison between the animals is not justifiable, but the figures show what is possible under varying environments. The following are the ranges obtained for the high yielders among different breeds:—

Breed	Lactation yield in lbs.		Yield per day in lbs. during lactation	
	Lowest	Highest	Lowest	Highest
Sahiwal . . .	7,138	11,721	20·1	33·8
Sindhi . . .	6,298	8,573	16·9	26·7
Tharparkar . .	6,457	8,734	19·9	27·9
Hariana . . .	6,985	8,426	19·5	26·1
Kankrej . . .	5,068	7,269	13·6	20·0
Gir	4,105	6,001	11·2	17·2
Murrah buffaloes .	6,063	9,891	17·9	26·8

During the year under review the Imperial Council of Agricultural Research decided to publish the available milk records of dairy cattle in India. Milk recording is not practised in

India, except on a very limited scale at some of the important dairy farms of the country, and the absence of records is felt alike by the trader, the breeder and the research worker. The Council decided to make a start in the direction of official publication of milk records by collecting and publishing those data which exist at present and which according to such surprise checks as could be carried out have been found to be reliable. The Provincial Governments as well as owners of private dairies kindly offered their whole-hearted co-operation and agreed to place all their records at the disposal of the Council. The first instalment of these records was under preparation for the press during the year.

CHAPTER X

VETERINARY AND ANIMAL HUSBANDRY RESEARCH

1. Animal health

ALTHOUGH considerable progress has been made in regard to the control of Rinderpest, the toll levied annually by this serious cattle menace as well as by other contagious diseases is still very high. It appears inevitable, therefore, that for some years to come measure designed for the effective control of these serious epizootics and their annual devastations will be one of the chief concerns of provincial veterinary staffs.

In preceding reviews it has been mentioned that the fixed virus, which is now employed in the control of Rinderpest outbreaks, is of reduced virulence for the ox and may be used in two forms, either (*a*) as blood drawn from an infected goat at the height of its reaction to an artificial infection with the virus or (*b*) as an emulsion, in saline solution, of the spleen of goats similarly infected. An essential pre-requisite of effective vaccination with either of these products is the use of a potent virus. No difficulty is experienced in maintaining the viability or antigenic value of these products during winter months when the atmospheric condition, particularly the temperature, in the plains in India is favourable. In summer and rainy seasons, however, when the demand for these products is greatest, the excessive heat exercises an adverse influence, and the virus which is extremely fragile deteriorates very rapidly and becomes inert long before it arrives at its destination. With a view to counteract the influence of a high temperature, extensive work has been carried out on improved technique and methods of preservation and as a result it is possible now to despatch the vaccine in ice in suitable thermos flask or other form of container, in which it is possible to maintain the antigenic value for a period which allows sufficient margin for transit and use in the field. This system, which is now in

vogue in many provinces and also in Burma, where a form of desiccated vaccine is employed for the routine control of Rinderpest outbreaks, has proved quite effective in warding off the danger of deterioration referred to above.

With the extensive experience gained in the use of these products, under varying conditions in the field, it has now become a part of the routine duties of the veterinary staff, almost all over India, to employ these vaccines in the control of Rinderpest outbreaks. The success achieved so far has been very encouraging and subsequent tests carried out on vaccinated animals have shown that the immunity conferred has been a solid one. The maximum interval which has so far elapsed from the time of vaccination to the time of the immunity test is a little over three years, while the mortality amongst indigenous cattle as a sequel of the inoculation has amounted to only a fraction of one per cent.

It is necessary to emphasise, however, that great care has to be exercised in dealing with buffaloes, in which the reaction provoked by goat vaccines is sometimes severe and the procedure should not be adopted in these animals as a routine without the simultaneous administration of a small dose of anti-Rinderpest serum. It has, for instance, been reported from Madras and Bihar that the goat virus alone method of vaccination in buffaloes has produced a severe reaction and a clinical syndrome analogous to that noticed in a natural outbreak of Rinderpest with a considerable mortality.

Experiments were carried out in the United Provinces with the object of computing the minimum dose of ordinary anti-Rinderpest serum which should be administered simultaneously with the vaccine to control the severity of reaction manifested by goat virus in buffaloes. The experimental evidence indicates that (*a*) the smallest protective dose of anti-serum should not be less than 20 c.c. per animal, (*b*) a dose of 4 to 6 c.c. per 100 lb. body-weight is sufficient to control the severity of reaction in buffaloes of all ages, (*c*) administration of serum at the rate of 6 to 8 c.c. per 100 lb. body-weight (with a minimum of 40 c.c.

per animal) is sufficient to control the adverse effect on milk yield. This dose is also effective in warding off the danger of abortion not infrequently noticed as a sequel of goat virus inoculation in buffaloes.

In MADRAS, the minimum dose of anti-serum recommended last year for serum simultaneous inoculations against Rinderpest, namely 6 c.c. per 100 lb. body-weight for cattle and 8 c.c. per 100 lb. for buffaloes and a minimum of 25 c.c. and 30 c.c. for cattle and buffaloes respectively, was found suitable in extensive trials carried out during the year under review.

At the MUKTESWAR RESEARCH INSTITUTE, further studies were made on the viability of Rinderpest virus outside the animal body. The strain of hill bull virus stored in glycerine at freezing point and passaged through hill bulls at monthly intervals has now been maintained in full virulence for four years. A strain of goat virus maintained under similar conditions and passaged through goats at intervals of 10 days has shown no variation in virulence over seventy-eight passages.

Estimations of the variations in the various fractions of the serum proteins have been made on buffaloes undergoing immunisation by various methods. It is hoped that the analysis of the mass of data accruing from this experimental work will eventually lead to a quicker method for the estimation of the potency of a serum and thus contribute to the progress in regard to the production of a highly potent anti-Rinderpest serum.

The success achieved during the past few years in the control of Rinderpest, as a result of the combined efforts of the laboratory and field workers, has done much to solve the problem of cattle improvement in this country. Field workers now possess an effective and valuable weapon and can feel more confident in dealing with this most important cattle plague of the tropics, for it is possible now to confer a lasting immunity on cattle of any breed at small expense and with the minimum amount of risk.

In a preceding chapter it has been observed that if grouped together Rinderpest and Hæmorrhagic Septicæmia account for

about 72 to 82 per cent of the total reported mortality from contagious diseases. Two biological products, namely an anti-serum and a vaccine, are issued by the Mukteswar Institute for controlling the losses due to seasonal outbreaks of Hæmorrhagic Septicæmia. The duration of immunity conferred by these products, though not as stable as in the case of Rinderpest vaccine, is still sufficient to help cattle in the danger zone to tide over the period of trouble, which in most provinces is limited to the rainy season.

Research was continued at the Mukteswar Institute in regard to other important contagious diseases and in particular to improve the vaccine now employed for the control of Black-quarter, the mortality from which is still very high. The use of this vaccine has yielded very satisfactory results in Madras where over 2,000 vaccinations were carried out as an experimental measure. Although it was stated that this vaccine conferred a durable immunity in about seven days after vaccination, and that during this period the inoculated animals were less resistant to a natural attack of the disease, the experience in Madras did not bear out the validity of this observation and it was found that the risk of loss through such lowered resistance was infinitesimal. Amongst 8,854 animals which were subsequently vaccinated the resultant mortality was only 8 and even these deaths could not be attributed to the use of this product. Again, a further trial on 24,491 cattle and 59 sheep and goats in the face of outbreaks resulted in the loss of only 31 cattle. This product has thus proved very efficacious and deserves wider application in the field as it is both cheaper and quicker than the " Serum-cum-vaccine " method, considerations which are a distinct asset for all biological products intended for mass scale adoption in the field.

Anthrax continued to be a serious source of loss in many parts of India and it is noteworthy that the incidence of this disease has shown considerable increase during the last three years. As was to be expected the distribution of anti-anthrax

serum by the Imperial Veterinary Research Institute, Mukteswar, has also increased considerably in this period, during which the amount supplied annually to the provinces has risen from thirty to ninety thousand doses.

A special spore vaccine for the purpose of conferring an active immunity against Anthrax has been employed in various countries for some time past with very satisfactory results and a similar product, which is being prepared from seed material obtained from Burma, was under test at the Imperial Veterinary Research Institute, Mukteswar. The initial tests carried out with the vaccine have shown that the bovine strain is safe for cattle and sheep in India even in large doses. Sheep were able to withstand 20 c.c. and cattle 50 c.c. of freshly prepared vaccine, but it has been found impossible to apply the same vaccine to goats, in which as low a dose as 0·001 c.c. proved fatal. It is proposed therefore to experiment with other strains with a view to prepare a suitable vaccine for goats.

The appointment of Veterinary Investigation Officers in the provinces and Hyderabad State, under a scheme initiated by the Council, has provided a chain of research organisation throughout the length and breadth of the country and has helped to form a valuable link between the Imperial Veterinary Research Institute at Mukteswar and the provincial institutions, where they exist, and, where there are no provincial organizations, to form a nucleus for research operations in provincial centres.

The scheme has already been in operation for five years in many provinces and sanction has been accorded for its continuance till the end of March 1940. The Advisory Board have also recommended that the Government of India should be approached for making permanent provision for the officers engaged under this scheme, thereby ensuring a continuity of work and progress in this direction and giving security of tenure to the staff, the absence of which it is apprehended will be derogatory to the value and usefulness of the research work at present being done.

During the year under review, a great deal of valuable information was obtained by these Veterinary Investigation Officers and it has been definitely shown that Bovine Surra is wide-spread in almost all the provinces and is responsible for heavy mortality. This disease, which appears during and after rains may assume serious proportions particularly in those years when the monsoon is heavy.

An outbreak of Paraplegia in horses was investigated in Bihar. Information collected from a number of affected cases suggested that the condition bore a close resemblance to Equine encephalomyelitis, the precise etiology of which still remains obscure.

Greater attention was paid during the year to the diseases of sheep and goats and a number of severe outbreaks of pox or variola in these animals were investigated and confirmed in many provinces. Goat pox which is generally regarded as a benign type of infection was responsible for heavy losses in some provinces.

An obscure infection was responsible for heavy mortality in the Jumnapari goats at Etah Farm in the United Provinces, where work on the improvement of goats is being carried out under a grant from the Imperial Council of Agricultural Research. Investigation into the etiology of this condition, carried out in collaboration with the Imperial Veterinary Research Institute, Mukteswar, suggested that the primary causative agent was probably of the nature of a filterable virus and that the massive parasitic infection detected in these animals was responsible for the secondary complications which hastened the mortality.

Heavy losses due to outbreaks of parasitic Diarrhœa in goats and sheep have been reported during the period under review from Bengal and some other provinces. Among the other diseases dealt with by the Veterinary Investigation Officers mention must be made in particular of contagious Pleuropneumonia of goats, Tuberculosis and Johne's disease, Coccidiosis, Bovine contagious abortion, Horn Cancer in cattle,

Anthrax in bovines, Equine encephelomyelitis, Fowl pox, Doyle's (Ranikhet) disease in poultry and deficiency diseases of live-stock.

The recently reported successful results in the prophylaxis of Rinderpest by camphor have led to the extensive application of this drug in Doyle's (Ranikhet) disease which, of the many diseases of poultry, is the most serious deterrent to the development of a very important cottage industry in India. The preliminary experiments presented encouraging results. When put to large-scale tests the findings were not so promising but there is sufficient data to show that, pending the establishment of better methods, camphor prophylaxis combined with scrupulous hygienic measures produces a certain measure of control, when none existed previously.

Several severe outbreaks of Fowl Pox have been reported from provinces during the year under review. This virus infection is not as mild as was previously thought to be the case, for recent experience has indicated that serious outbreaks, frequently diphtheritic in type and attended by considerable mortality, occur in poultry flocks in many parts of India. Fowl pox vaccine has given good results in the field and there is now an increasing demand for this product.

Equine encephalomyelitis has figured largely during the last few years and the disease appears to have established a firm footing in certain areas and its incidence is apparently increasing. A number of sporadic cases have been encountered in fresh centres during the year under review. Extensive laboratory investigation from different aspects, *viz.*, nutritional, biochemical and bacteriological, was carried out and it has been possible to demonstrate the presence of a filterable virus. That this virus might have an important significance in the etiology of this condition was suggested by the histological examination of the brains of experimental mice in which the lesions were similar to those noticed in the brains of affected horses.

The isolated virus was maintained without any apparent loss of virulence for fourteen passages but attempts to transmit it to horses by intra-nasal inoculation were not successful. It is stated that the failure to transmit the infection may perhaps be correlated with some accessory factors about which little is known at present and which may be essential for the establishment of infection.

Pleuro-pneumonia of goats, a disease encountered chiefly during the lean months of the year when grass and herbage are scarce, was responsible for heavy losses in many parts of the country and called for urgent investigation and research into the etiology of this condition. The evidence collected so far indicates that this condition is primarily a form of broncho-pneumonia and that most goats are potential victims of the disease. The acute terminal phase of the disease is determined by a breakdown of tissue resistance consequent on lowered vitality induced as a result of mal-nutrition, when secondary organisms normally present in the respiratory tract flare up and produce septic pneumonia which completes the syndrome.

The problem of abortion, both in cows and horses, has been studied from the nutritional aspect and it has been shown that many cases of abortion cannot be referred to a primary bacterial etiology. Attention has therefore been directed to the role of mineral and nutritional deficiencies and their possible primary significance in the etiology of this morbid condition. In the case of cows there is evidence to show that mineral deficiencies and abortion are frequently correlated, as treatment of certain selected herds by enhanced nutrition effected a marked amelioration in the incidence of abortion.

Similar attempts to correlate malnutrition with abortion in mares did not yield any positive results, although in some cases significant variations in blood calcium were observed.

Diseases of pigs also received attention during the period under review and *Pasteurella suis*, the causal organism of Swine Plague, was recorded for the first time in this country. The

organism was recovered from an outbreak at a pig farm in the United Provinces where it was responsible for heavy mortality.

An acute outbreak of Swine Fever which was responsible for heavy mortality was reported from Bengal and it was observed that serum prepared from recovered animals gave encouraging results in the control of the epizootic.

In the Helminthology Section at Mukteswar the life-history of a common tape-worm of dogs and cats—*Mesocestoides lineatus*—was partially worked out. The secondary larval stage of this tape-worm was found encysted on the serous coat and the liver of a local snake, lizards and wild rats. The primary larval stage remains to be discovered.

The gizzard worm of poultry has been found to be of common occurrence and the whipworm *Trichuris* sp. has been found in two dogs and immature specimens of *Fasciola gigantica* have been found in an abnormal situation—the lung of a goat. An outbreak of pneumonia in sheep was found to be due to *Protostrongylus rufescens*.

In the Protozoology Section at Mukteswar research was carried out on a number of important protozoan infections and in regard to Piroplasmosis in bovines it is particularly interesting to note that the European piroplasm, *Babesia bovis* infection, which is now recorded for the first time in this country, was observed in blood smears from a buffalo sent to the Institute by the Officer-in-charge, Military Dairy Farm, Belgaum.

Another important parasite, *Eimeria arloingi*, which is considered to be highly pathogenic to goats, was detected in about ninety per cent of samples of fæces received from an outbreak in a goat farm in the United Provinces.

In continuation of the work on acute bovine Trypanosomiasis reported last year, further work was prosecuted on the identity of parasite involved in the etiology of this condition. As far as can be judged, the results of various techniques employed for this purpose lead to the conclusion that the parasite of

Bovine Surra is none other than *Trypanosoma evansi*, which is responsible for Surra, a fatal infection in equines and camels.

Reference was made in the preceding review about the proprietory preparation, Akiron R, which has proved highly successful as a curative in the treatment of cases of Red-water of cattle due to *Babesia bigemina*. This drug was extensively employed, with invariable success, for the control of this infection, both in cases of resuscitation during routine Rinderpest work and also in cases of primary affection. This valuable product has thus rendered it possible to produce a ' Piroplasm free ' Rinderpest virus.

In regard to Theileriasis of cattle, further observations were carried out to determine the optimum point at which to bleed for the production of a potent anti-serum and the results obtained lend support to last year's finding that the ' brew ' manufactured at the stage of complete or nearly complete disappearance of parasites from the peripheral circulation of the donors was the most potent. This product has been used by the Army Veterinary authorities, in natural cases of acute Theileriasis in imported bulls, with satisfactory results.

In the Entomology Section at Mukteswar an investigation was initiated upon the warble fly pest in India, under a grant from the Imperial Council of Agricultural Research. The investigation has already resulted in the acquisition of valuable knowledge concerning the seasonal occurrence of the pest in certain localities in India. Thus, while the occurrence of warble tumours in cattle was noticeable at Mukteswar from early January to the first week of March, all available evidence shows that in the Punjab the full grown grubs leave their hosts not later than the middle of January. A systematic examination of hill bulls at Mukteswar for the presence of warble tumours revealed that more than fifty-five per cent of these animals were affected, as against sixty per cent observed among dairy cows born and bred at the Institute. The winged form of the pest has, however, not been encountered so far, though two adult specimens of *Hypoderma lineatum* were successfully bred

out from grubs that had been entrapped while in the process of escaping from warble tumours. It is hoped that the results of this systematic investigation into the bionomics and life-history of this pest will eventually prove of considerable value to the hide trade of this country.

The presence of the Spinose Ear Tick (*Ornithodorus megnini*) in India was demonstrated for the first time last year in material collected from the ears of an Australian army horse. Further investigation, during the year under report, has shown that the species is more wide-spread in India than was originally believed to be the case, for its occurrence has now also been reported from two other stations, although none of the horses concerned in these cases showed any marked clinical symptoms of the infection. The total number of cases detected so far at three stations is 81 and at one of these out of a total of 523 horses, examined for the presence of these ticks, 68 or nearly 13 per cent harboured this parasite. It is interesting to note that a large percentage of these affected horses were originally imported from Australia, where this tick is not known to exist. The available evidence points to the conclusion that this tick was originally introduced into India by stock imported from America or South Africa. Observations on the life-history of the parasite showed that under experimental conditions, the incubation period of the eggs was 53 days, and the larvæ, after being introduced into the ear of a horse, emerged as fully engorged nymphs after an interval of 35 days.

The scheme for the establishment of a Poultry Research Section at Izatnagar, under the administrative control of the Director, Imperial Veterinary Research Institute, Mukteswar, was sanctioned by the Government of India during the year under review and arrangements for the recruitment of the necessary staff and construction of buildings for this section are in progress.

In MADRAS, the diseases of sheep and goats were the subject of special investigation during the year under report for it has been observed that many contagious diseases, particularly

Pleuro-pneumonia in goats, Anthrax in goats and sheep, Hæmorrhagic Septicæmia in sheep and ovine and caprine types of variola or pox infection are responsible for heavy annual mortality amongst these animals.

Various virus and bacterial infections of poultry, notably Fowl Pox, Doyle's disease and Fowl Cholera have been instrumental in decimating large flocks of poultry every year in Madras and have proved a serious hindrance to the improvement of this important cottage industry. Intensive investigation and research have been carried out on these conditions with a view to devise effective measures for systematic control of these diseases.

A detailed study was carried out on the histopathology of Rhinosporideal growths in bovines and it has been observed that these growths are located in the proximity of the hole punctured for the nose string and they were also noticed in animals showing lesions of Nasal Schistosomiasis. It is therefore surmised that the route of infection in bovines is associated with trauma. It is interesting to note that in human beings this disease has been noticed mostly in agriculturists—an observation which suggests that there is some correlation between the organism found in bovines and in man. The study of the organisms in sections of lesions from both human and bovine subjects shows such close similarity as to lead to the belief that they are identical.

Other interesting findings were : the co-existence in the same bullock of *Setaria digitata* in the anterior chamber of the eye and *Thelazia rhodesii* on the mucous membrane of the eye, Oocysts of *Eimeria faurei* in goats, identification of a species of Leucocytozoon from a fowl, a species of Microfilaria in the blood of a fowl and a combined infection of *Trypanosoma theileri* and *Babesia bigemina* in a calf aged 15 days.

In BENGAL, investigation was carried out into the cause of Ophthalmia and blindness in weaned calves and night blindness in cows and vitamin A deficiency has been incriminated in the etiology of these pathological conditions.

In the UNITED PROVINCES, outbreaks of Bovine Trypanosomiasis were investigated and confirmed in several districts. Blood obtained from affected bovines produced identical infection in experimentally inoculated rabbits and the parasite involved in these outbreaks was indistinguishable from *Trypanosoma evansi*. The heavy mortality and severity of infection appeared to be correlated with the heavy monsoon experienced all over the province during the year.

In MYSORE, outbreaks of Anthrax were severe and widespread and investigation revealed that the cause of severe mortality among sheep in certain areas was due to a strain of the Anthrax bacillus which was particularly virulent for sheep. This particular strain was isolated and was used for the preparation of an autogenous specific vaccine which when employed for control work in the field yielded encouraging results.

Outbreaks of Anthrax among sheep and goats and contagious Pleuro-pneumonia in goats were encountered and confirmed by the Veterinary Research Officer in the course of his tours. Valuable information was also collected in regard to the nature of polypoid growths and a definite proof of their malignancy in the internal organs, principally liver and lungs, was obtained. The carcinomatous nature of the cells constituting the growths suggests an inter-relationship with cancer of the horn as well as that of the eye.

2. Animal Nutrition

THE Physiological Chemist's Section at Bangalore was placed under the administrative control of the Director, Imperial Veterinary Research Institute, Mukteswar, from the 1st April 1936. Later in the year the Section was transferred to Izatnagar and the designation of the Physiological Chemist was changed to Officer-in-Charge, Animal Nutrition Section. The main functions of this reorganized Animal Nutrition Section will be the study of nutrition in relation to the maintenance of health, normal growth and productive capacity of animals in

India and its main items of work have been defined as follows:—

1. Analysis of the important food-stuffs of India.
2. Analysis of the pastures of typical grazing areas.
3. Digestibility and utilisation experiments on food-stuffs of all-India importance.
4. The physiological significance of the inter-relation of food-stuffs.
5. Co-ordination of the nutrition work done at the Central Institute and at Provincial Centres.
6. Diet in relation to growth.
7. Diet in relation to milk production.
8. Diet in relation to work.
9. Diet in relation to wool production.
10. Diet in relation to production of hides and skins.
11. Diet in relation to breeding problems.
12. Mineral requirements.
13. Vitamin requirements.
14. Collaboration with agriculture on factors affecting the composition of food-stuffs.
15. Collaboration with Mukteswar regarding the influence of nutrition on susceptibility to disease.
16. Basal metabolism.

The Section was able to complete some interesting experiments during the year. A study of the sulphur-content of Indian grasses revealed that amongst grasses growing side by side in the natural state, the species of the tribe *Chloridae* contained more sulphate than others and that the stalks of grasses contained more sulphate than the leaves, excepting in lucerne where the reverse was the case.

An experiment intended to determine the effect of sulphur supplement on the mineral balance in bullocks was also completed during the year. It was commenced with a view to study (i) the effect of sulphate supplement on the calcium and

inorganic phosphate content of blood and urine, and (ii) the effect of alkalies and acids on the calcium and phosphate in the blood. The data available from two mineral balance tests, conducted in this connection, showed that calcium sulphate supplement raised the sulphate content of blood serum and urine. The calcium level of serum was slightly increased, but that of phosphorus lowered. Supplements of sodium and potassium acetates along with calcium sulphate lowered the excretion of sulphates, calcium and magnesium, and raised the excretion of phosphates in urine as compared with the level of excretion with only calcium sulphate supplement. Ammonium sulphate gave similar results as calcium sulphate.

Work was continued on sulphur metabolism and on a modified technique for the determination of total sulphate in blood serum. As regards the latter, the optimum acidity and time required for complete hydrolysis for the quantitative precipitation of sulphate, and for keeping the phosphate in solution have been studied.

A feeding experiment was carried out with a view to determine the maintenance requirements of hill bulls and two trials were conducted to find out the digestibility of the fodder and the nitrogen and mineral balance in these animals.

The preliminary haematological investigations on the animals of the Bangalore Farm, commenced two years ago, were concluded this year. The investigation consisted of Erythrocyte, Leucocyte and differential counts of the dairy herd. It was found that Indian cattle possessed a higher percentage of red blood cells than foreign animals and the percentage of counts in cross-bred cows was the same as in foreign animals. No variation was noticed, either in the percentage of Leucocytes or in differential counts, between Indian and foreign cattle.

At Coimbatore an investigation was made on the possible co-relation between the work turned out and protein consumed by working bullocks. To this end, two sets of animals were employed at work for 8 hours and 6 hours a day, when it was

found that while the quantity of protein required by the animals working for 8 hours was 500 grams, the animals working for 6 hours required only 400 grams. The conclusion drawn from this is that the protein intake is a linear function of the quantum of work and that the tissue breakdown is proportional to the strain imposed.

Work under the scheme financed by the Imperial Council of Agricultural Research included analysis of mineral content of a number of grasses which disclosed a marked deficiency in minerals in localities representative of hill slopes near Coimbatore, while pastures in the Ongole Taluk of Guntur district showed grasses of excellent quality with a high content of lime and phosphoric acid.

In regard to the mineral metabolism of dairy cows and young stock experiments on mineral balance in regard to lime and phosphoric acid showed that for growth the young stock required a ratio of 1 : 1, while in the case of cows the ratio for milk production was 2 : 1. It was also observed that cows in heavy milk showed a negative balance for calcium while dry cows in calf showed a positive balance. As regards phosphoric acid it appeared that the animals were getting sufficient as the balance was positive. The digestibility co-efficient of the mineral matter in the ration fed was noticed to be very low being of the order of 4-5 per cent of the total quantity ingested. The results obtained so far indicate that a daily intake of about 35 grams of calcium and 30 grams of phosphoric acid meets the requirements of growing calves and in the case of cross-bred (Ayrshire × Sindhi) cows, the requirement of calcium and phosphoric acid is in the ratio of 2 : 1 with a daily ingestion of 70 and 35 grams respectively per 1,000 lb. live-weight.

At Dacca, another scheme financed by the Imperial Council of Agricultural Research produced a mass of valuable information during the year under review. A study was made of the mineral requirements of cattle under Bengal conditions and

the main findings that emerged from the rice straw feeding experiments were :—

1. that lime assimilation was poor,
2. that a positive lime balance could not be obtained until the intake was increased to about 24 grams of CaO per 500 lb. live-weight,
3. that when rice straw is the principal roughage lime requirements were higher than the generally accepted standards, and
4. that a rice straw diet involved a large ingestion of potash which possibly interfered with lime assimilation.

In these experiments rice straw did not induce diuresis as was noticed by Dr. Warth who was of the opinion that the " Diuresis is intimately related to potash ingestion ". In fact when straw was fed alone the amount of urine passed was lowest.

Judged on the basis of experimental work under reference the main mineral requirements (when rice straw forms the main roughage) appear to be 24 grams CaO, 10 grams P_2O_5, 15 grams MgO, 70 grams K_2O, 17 grams Na_2O, and 20 grams Cl_2 per 500 lb. live-weight.

It was further observed that the feeding of Napier grass in large amounts led to complications. There was deficiency of lime and this appeared to react on the assimilation of phosphorus.

The results also showed that under Bengal conditions of feeding there is a greater liability of phosphorus deficiency than that of lime and that a small supplement of cake or material rich in assimilable phosphorus can appreciably improve the condition.

Feeding and digestion experiments with different rice straws revealed that *aman* straw was inferior to *aus* or autumn straw and that the nutritive value of *boro* straw was about as good as

that of *aus* straw. There is every probability that *aus* straw, which is harvested when it is slightly green, is richer in vitamins than *aman* straw which is generally harvested when dead ripe. This combined with a better mineral content might account for the better results obtained when feeding *aus* straw.

In the PUNJAB, an investigation was carried out during the year at Lyallpur on the feeding values of various farm commodities.

Feeding trials with cotton seed cake produced from '4F' American cotton seed without any preliminary delinting or decortication have shown that such cake is a highly nutritious and economic food, comparing most favourably with the whole cotton seed and showing a very satisfactory comparison with *sarson* and *toria* cakes. The digestibility figures for all the ingredients were high. The digestible protein amounted to 18 lbs. per cent and expressed in terms of price per pound of digestible protein, the cost of the cotton seed cake based on the current Lyallpur prices is 6·7 pies against 17·6 and 18·2 pies respectively for *sarson* cake and *toria* cake.

Similar work has been carried out with decorticated cotton seed cake, but the results have not been published yet.

Feeding trials with crushed soyabeans have shown that this is one of the richest concentrates available, possessing 35 per cent of protein with a digestibility co-efficient of 85 and containing 32 lbs. of digestible protein and 85 starch equivalents per 100 lbs. of feed.

Other feeding trials carried out with *anjan* grass, cut at an early stage in its growth on the one hand and when it was fully ripe on the other, formed a preliminary investigation leading to further work in connection with the proper farming economy of grass systematically grown as a fodder crop. It is a well established fact that if grass can be cut systematically during the growing season a much greater quantity of fodder, and at the same time a much more nutritious feed, can be obtained than if the grass is cut after it has reached the fully ripe stage.

Feeding trials with oat silage, which had been kept for four years and which formed part of the experiment to determine the changes which occur in silage stored for a period of five years, showed that the silage continued to retain its condition with little change either in appearance or nutritive value during this long storage.

In BIHAR, the scheme for the analysis of indigenous fodders, financed by the Imperial Council of Agricultural Research, started functioning from the 1st April 1936 and the report for the year under review deals only with preliminary work and confines itself to general analyses of 33 indigenous fodders.

3. Dairy Research.

IN the domain of dairy research the Imperial Dairy Institute at Bangalore was able to complete work on a number of items. In addition to routine experiments, special investigations were carried out and some interesting results, which are summarised below, were obtained during the year under report.

In regard to the loss of butter-fat in the preparation of butter, it was observed that the addition of citric acid and sodium citrate minimized the loss of butter-fat in buttermilk and also improved the aroma, flavour and keeping quality of butter. The most suitable percentage of fat in cream for the minimum loss of butter-fat was found to be 30 per cent and the optimum temperature for ageing 48 to 52° F. and for the churning of cream 54 to 56° F.

Organisms responsible for the introduction of an attractive aroma in butter, prepared by indigenous methods, have been studied and efforts are being made to isolate pure cultures of these organisms.

In regard to the comparative efficiency of different cleansing agents for sterilisation of milk bottles it was found that steaming for five minutes was quite effective, as also was perchloron solution in dilution of 1 in 10,000 parts of chlorine.

Experiments in connection with the yield of the cheddar type of cheese in relation to the fat content of milk showed that in India the optimum fat percentage for economic manufacture of cheese of good flavour and texture is 3·5 to 5.

Research into the composition of milk, financed by the Imperial Council of Agricultural Research for a period of two years, was undertaken at the Agricultural Institute, Allahabad, from 1st July 1936. The object is to obtain comprehensive analytical data which would be helpful for laying down suitable standards for milk. The results will also be of use to workers in human nutrition as well as to those concerned with the computation of rations for milch stock. The results of the first year's working contain analyses of samples of milk of cows and buffaloes of different ages, calving at different seasons of the year, and at all stages of lactation. After the completion of the work the data will be statistically studied with a view to formulating definite conclusions regarding the mean and range of variations of the different constituents of milk, obtained under the different conditions mentioned above.

The Imperial Agricultural Research Institute, New Delhi, does not undertake dairy research as such but is mainly concerned with the maintenance of a very valuable pedigree herd of Sahiwal cattle. All the milk produced at this Institute is sold as liquid milk. Investigations were, however, carried out here on dairy hygiene and methods of producing milk having a minimum bacterial content. Work was also carried out in connection with the isolation of suitable strains of lactic acid producing organisms from *dahi* (curd).

CHAPTER XI

VETERINARY EDUCATION AND INSTRUCTIONS IN DAIRYING

1. Veterinary Colleges

THE dearth of adequate facilities for imparting the highest standard of veterinary education in India, such as would secure international recognition and equip young Indians for appointment to the superior Provincial Veterinary Services, the Indian Army Veterinary Corps and other specialised and research appointments has been referred to in the preceding reviews. The question was discussed at length at the Second Meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry, held at Madras in December 1936, and as a result of the deliberations a proposal was made for the establishment of a Central Veterinary College in which the course of instruction would be equivalent to that laid down for the diploma of the Royal College of Veterinary Surgeons, England. The matter is at present under the consideration of the Government of India.

Punjab Veterinary College. The number of applicants for admission to the four-year Diploma course was 122 and of these 75 secured admission during the academic year under review. The total number of students at the College at the end of the year was 133. Of the 11 students who appeared for the final examination, 5 were successful in securing the Diploma of Licensed Veterinary Practitioner offered by the College.

Amongst other facilities for training available at this College, 36 candidates completed their training as dressers. Two farriers' classes were also held and 31 candidates passed the courses in June, 1936 and March, 1937.

Bombay Veterinary College. A notable feature of the year was that this College completed the fiftieth year of its existence and as a mark of appreciation of the services rendered by this Institution, Golden Jubilee Celebrations, which were attended by His Excellency the Governor of Bombay, were held on 30th December, 1936. The Ninth All-India Veterinary Conference was also held at the College at the same time, with Mr. F. Ware, C.I.E., F.R.C.V.S., I.V.S., Director, Imperial Veterinary Research Institute, Mukteswar, as the President. Nearly 200 graduates from all parts of India attended the Conference and the Golden Jubilee Celebrations.

The number of students on the rolls at the end of the year for the three-year Diploma course was 113 as against 103 at the commencement of the session and of these 34 held stipends and the rest were private students. Eleven students graduated during the academic year 1936-37 and almost all are reported to have secured employment. It is stated that there is a great demand for the graduates in Government and Indian States and that all the qualified graduates have secured employment.

Madras Veterinary College. In the previous review, it has been mentioned that this College has been recognised as a constituent college of the University of Madras for imparting instruction for the degree of Bachelor of Veterinary Science. The four-year B. V. Sc. Degree Course was introduced from July, 1936 and under the orders of Government the number of students belonging to this Presidency to be admitted to the Degree and Diploma courses at the Madras Veterinary College has been restricted to 30, *i.e.*, 15 each for the two courses. In addition to this number Government have accorded permission for admitting students from other provinces and Burma to a maximum of 20 for both the Degree and the three-year Diploma courses.

The strength of the first year class at the end of the year was 50 consisting of 28 Degree course and 22 Diploma course students. The total strength of all the three classes at the end of the year was 101 (50 in Class A, 27 in Class B, and 24 in

Class C) as against 96 last year. Out of the 7 students who appeared for the final examination of the Diploma course, 6 qualified during the year under review.

Bengal Veterinary College. During the last few years an increasing demand has been made for admission into this College from the various provinces in India and also from outside India. The number of students on the rolls at the end of the year for the three-year Diploma course was 184 as against 170 and 174 during the preceding two years. Of the 184 students 58 were stipendiaries and the rest private students. The District Boards of Bengal awarded 28 stipends during 1936-37 as against 21 in the previous year. An old student of Class C was re-admitted during the year. 63 students appeared for the final examination in 1936-37 and of these 41 were successful in obtaining the diploma.

According to the revised curriculum of studies approved by Government, a laboratory for the examination of milk and milk products and for giving practical instruction to final year students was started during the year in a separate building within the annexed compound, in which the Dairy Science and Milk Hygiene classes are held.

Bihar Veterinary College. During 1936-37, 29 new students joined the College as against 36 in the previous session. The number of students on the rolls for the three-year Diploma course was 73 and of these 22 were stipend holders and the rest private students. Altogether 71 students appeared at the examinations and out of these 50 passed, namely 20 in the first year, 18 in the second year and 12 in the final year.

Insein Veterinary College. The third batch of students taking the one-year course for the new grade of Veterinary Assistant completed their training in October, 1936. Of the 18 students who entered for the course, 14 were successful during the year and 11 of these graduates were appointed to posts in the subordinate grade of the department. The fourth

batch consisting of 16 students was recruited in November, 1936 and of these 6 were awarded Government stipends.

Two State scholars were sent to the United Kingdom to study Veterinary Science and were admitted to the London and Dublin Veterinary Colleges.

2. Post-graduate Courses in Veterinary Science

The annual post-graduate refresher course at the Imperial Veterinary Research Institute was held from the 6th April to 4th July, 1936 and 10 officers attended the course.

After attending the post-graduate course an officer from Iraq completed the period of one year's training for which he was deputed to the Institute by the Iraq Government. The research scholar from the Punjab who was undergoing a two years' training completed his course on 18th April, 1936 and another Veterinary Assistant Surgeon from the Government Cattle Farm, Hissar, reported on 12th October, 1936, for two years' training. A Military Veterinary Assistant Surgeon remained at the Institute for a course of training for about five months.

In addition to the post-graduate refresher course, short courses of practical training were given at the Institute to eight officers.

At the Punjab Veterinary College, three Veterinary Assistants of the district cadre attended a refresher course in Pathology, Parasitology, Bacteriology and Meat and Milk inspection.

At the Madras Veterinary College nine students attended the revised refresher course for Veterinary Assistant Surgeons which was introduced from July, 1935.

The post-graduate training class at the Bihar Veterinary College, which was reopened last year with a shorter course of three months, was attended by 6 students as against 9 during the preceding year.

3. The Indian Dairy Diploma

ACCORDING to the accepted practice of admitting students every two years for this course, no new students were admitted to Bangalore. The batch of twenty-four students who joined the course in November, 1935, continued their training during the year. Four repeat-course students were also admitted for the final examination to be held in October, 1937.

At the Agricultural Institute, Allahabad, the Indian Dairy Diploma course was continued during the year under review and 31 students were admitted of whom 24 were on the rolls at the end of the year. Of the 9 students who appeared for the final examination, 6 qualified for the diploma.

A grant of Rs. 6,000 a year was sanctioned by the Government of India for the continuance of this course. A scheme of alterations and addition to the equipment and cattle was adopted and is being given effect to. These additions have greatly improved the facilities available at this Institute.

4. Post-graduate courses in Dairying

AT the Imperial Dairy Institute, Bangalore, five post-graduate students who were admitted in January, 1936, for a course in Animal Husbandry and Dairying completed their training at the end of March, 1937 and a fresh batch of 6 students was admitted in January, 1937.

Special short courses were arranged for 11 students for periods varying from one to six months, and three British soldiers completed a vocational training course in February, 1937. Another batch of 12 British soldiers was admitted to this course in March, 1937.

CHAPTER XII

DISTRICT WORK

In this Chapter a brief account will be given of the principal methods of propaganda employed in the different provinces and of any changes during the year. Progress in the introduction of improved crops can be judged to some extent from the fact that the ascertained area under such crops was over 23·9 million acres as compared to 21·4 million acres in 1935-36. Progress in the introduction of improved seeds, implements and manures has been maintained during the year under report. An increased tendency on the part of the cultivators to recognise the importance of improved methods of farming is reported by almost all provinces and States. This progressive change in the outlook of the farming classes is a most welcome feature of the district work.

1. Demonstration

The ocular demonstration of agricultural improvements on the cultivators' own lands under village conditions still continues to be the most efficient and reliable form of propaganda. Such work is carried on by the district staff of Agricultural Departments in co-operation with keen and progressive cultivators and is supplemented by the activities of co-operative organisations and other local bodies. The method is being applied in different forms in different provinces and the rural uplift grant from the Central Government has been of great help in launching schemes of concentrated demonstration and propaganda in the villages.

In Madras, demonstration plots on important crops during the year numbered 7,554 as against 7,214 in the previous year; while trial plots were 902 as against 913 in the previous year. The number of central villages in which the demonstration staff worked in each taluk remained the same as in the last year,

A reference was made last year to the attempt made to intensify propaganda by the appointment of sixty-three demonstration *maistries* in nine taluks of the Vizagapatam district. This is the second year of the working of the scheme. Apart from the demonstration work of the department, the services of these *maistries* were utilized in the general uplift of the rural population by inculcating in them the idea of better living. Though all demonstration *maistries* did not come up to the standard expected, they have been able to bring the department and its activities to the notice of a large circle of ryots in those villages in which they worked. An outstanding feature of the propaganda work done during the year was in connection with a severe outbreak of *mahali* disease in areca-nut gardens in South Kanara. This disease took a very serious turn and penetrated into places where it had never been found before. Government sanctioned a special staff of two agricultural demonstrators, ten fieldmen and thirty climbers to meet the situation and to demonstrate sanitary measures. Sixty tons of chemicals and 800 sprayers of different makes were made available to the ryots. During the year, 2,795,527 trees were treated both in Malabar and South Kanara districts. A campaign against an insect pest (*Nephantis serinopa*) on coconut was also carried out in certain villages in Malabar, and remedial measures were demonstrated on 4,982 trees. Demonstrations were also held on die-back of citrus, stem bleeding disease of coconut, and hairy caterpillar on groundnut.

In BOMBAY, during the year under report, the district activities of the Agricultural Department in connection with demonstration and propaganda seed distribution, land improvement, crop protection, etc., continued to develop in almost every district of the presidency. A notable feature of this work was the increased interest taken by the cultivators in land improvement schemes whereby using simple but scientific methods of bunding and the construction of field embankments, cultivated lands were protected from permanent damage and loss by soil erosion. In Nasik district, an area of 3,250 acres was protected

in this way and in the South Central Division over seventy minor "bunding" projects involving 1,804 acres of land were framed and carried out with the assistance of the staff of the department. Similar work made rapid progress in certain Karnatak districts.

In the Southern Division, extensive propaganda work was undertaken to spread the practice of spraying with Bordeaux mixture as a control measure against the *koleroga* disease in betelnut palms. In Siddapur taluk, an area of 2,000 acres was sprayed as against 1,615 acres in the previous year. This work was organised in 101 villages. Similar work was carried out in some taluks of Kanara district. The total area sprayed was 3,516 acres as against 3,156 last year. The district staff of the department has been concentrating upon the improvement of village manure supplies by the introduction of methods of conservation and of compost manufacture. This work has now been taken up by the public in several areas. The district officers organised a very large number of propaganda meetings many of which were attended by prominent non-officials and the local officers of the Departments of Government.

Intensive propaganda was continued during the year under the plant-puller propaganda scheme of the Indian Central Cotton Committee and thousands of plant-pullers were distributed. In Broach, Amod and Wagra taluks cotton stumps were uprooted in about ninety-five per cent of the cotton area. In the areas south of the Nerbudda about forty-six per cent of the total cotton area was stumped after harvest. Work is now being concentrated in backward taluks with the ultimate object of securing a hundred per cent clearance in the Gujarat cotton-growing tracts.

In BENGAL, the jute restriction campaign was continued and intensive propaganda was launched in order to induce the cultivators to grow substitute crops. A sum of Rs. 20,000 was spent in supplying such crops as *aus* paddy, groundnut, sugarcane, etc. The scheme for the establishment of seed,

paddy and crop demonstration centres was financed from the Government of India's grant for rural uplift and 450 demonstration and seed multiplying farms have been set up in the Union Boards. The department's programme of demonstration has attracted considerable public support. District and Union Boards as well as Khas Mahal Court of Wards Estate and private individuals have taken a greatly increased interest and have provided funds for demonstration staff and for distribution of pure seeds. Concerted action for the destruction of water-hyacinth by the organisation of voluntary labour was effectively organised in several sub-divisions. The Bengal Water-hyacinth Act, 1936, was put into force during the year in several districts.

In the PUNJAB, fifteen agricultural assistants and fifteen trained demonstrators (*mukadams*) were added to the district demonstration and propaganda staff during the year. This brings the total strength of the cadre of agricultural assistants and *mukadams* for district demonstration and propaganda work to eighty-eight agricultural assistants and 146 *mukadams* for 37,131 villages in the whole of the Punjab. Proposals have been made to Government that the district demonstration staff should be further increased to a minimum of one agricultural assistant and two *mukadams* for each tehsil. During the year, the district staff laid down 4,866 demonstration plots as against 3,309 during last year. The departmental staff continued to carry out its annual propaganda in favour of eradication of *pohi* (*Carthamus Oxyacantha*) although such campaigns are not proving very useful. Farmers' weeks were held as usual at the headquarters of each Deputy Director of Agriculture, except Hansi where the response to the previous attempts of holding the farmers' week was so poor that the proposal had to be abandoned. Elsewhere these farmers' weeks appear to become more and more popular each year. The Nili Bar Colony scheme, which was brought into being by Government in 1930 to introduce the element of competition in the adoption of improved methods of agriculture by offering as

prizes half rectangles of land for a period of three years to the two cultivators in each village who farm their own land by the best methods during the previous years, has met with great success and Government has decided recently to extend it to the Pir Mahal and Khikha extensions of the Lower Chenab Canal area. Many of the holdings of the competitors in the Nili Bar Colony were models of good cultivation and the scheme has had an undoubtedly beneficial influence on the farming of that tract.

In BURMA, in the past year only a very small budget allotment averaging Rs. 2,620 per circle (about Rs. 620 per district) has been available for demonstration work. This amount has been supplemented in the case of cotton in the Myingyan Circle and more recently in the case of sugarcane in the East Central Circle by special crop grants derived from the particular industries concerned. This has permitted a greatly extended demonstration programme in the circles concerned. In the Myingyan Circle during the year under report, the extra grants permitted the employment of thirty-one temporary demonstrators and the working of ninety-one demonstration holdings under four main heads :—

(1) Line sowing with intercultivation.
(2) Contour bunding to check erosion.
(3) Storage of farmyard manure.
(4) Demonstration of improved ploughs.

Similarly in the Eastern Circle, the supplementary grant has enabled considerable extension of demonstration work. In all the circles in the dry zone, purchases by the department from demonstration holdings for local distribution were as usual.

In BIHAR, the Department has now fifty-three overseers and 138 farm trained demonstrators (*kamdars*) with a grant of Rs. 9,300 for demonstration work throughout the province. In addition to those paid from provincial revenues, there were another thirty-three overseers and ninety-nine *kamdars* paid from the grant made by the Government of India

from the sugar excise fund, whose main function was to demonstrate improved methods of cane cultivation and to distribute setts of disease-free varieties. During the year under report the Department carried out 15,167 demonstrations on cultivators' plots, as against 8,900 demonstrations in 1935-36. This represents almost a hundred per cent increase and is a sufficient testimony to the appreciation of the value of the demonstration work on the part of small growers. That the department's findings when put into practice under large scale farming conditions in North Bihar are capable of returning handsome dividends is shown by the commercial farms of the Bettiah Estate. The Byreah Farm showed a profit of Rs. 6,237 during the year, while the other two (Madhopur and Lalsoriya Farms) produced a profit of rupees 26,187. These three farms are not only model demonstration farms run on commercial lines but they serve as centres for the dissemination of improved agricultural practices amongst the Estate's tenants.

In the CENTRAL PROVINCES, village uplift activities were continued in all the districts. These include the digging of pits for the conservation of manure, general cleanliness of the village, advice and demonstration regarding the growing of profitable crops and more economic methods of cultivation and establishment of Village Seed Unions to inculcate thrift and self-help. In the Southern Circle demonstrations were held at 1,705 centres. In the Eastern Circle three of the five Government demonstration plots, which were in existence last year, having served the purposes for which they were opened, were closed down. One new plot was opened at Bhilai. Twenty-seven private demonstration plots were run at the expense of the owners under departmental supervision and all except the one newly opened at Kargi made substantial profits. Practical demonstrations numbered 2,803. Farmers' days were organised on two Government farms and on three demonstration plots. In the Western Circle, all the Government and private demonstration plots run under the direct control or according to the district staff's advice have shown good results financially. A

comprehensive systematic programme of agricultural propaganda was drawn up for fifty-nine villages where rural uplift activities are being carried out.

In ASSAM, the demonstration of improved varieties of seeds was conducted on the cultivators' fields on the lines of the previous years. Usually one-half of a demonstration plot was sown with the ordinary variety and half with an improved variety. The crops were harvested separately and the outturns recorded for comparison. Manurial demonstrations on paddy with *dhaincha* as a green manuring crop and with oil-cake broadcast were conducted in the Surma Valley. *Dhaincha* appreciably increased the yield but the effect of oil-cake was not very encouraging. During the year under report another sum of Rs. 20,000 was obtained by the department from the subvention by the Government of India for the continuance of the demonstration of *boro* cultivation on *aman* land, liable to early flood. The number of pumps working under the direct supervision and management of the department was seventeen against eleven in the preceding year. A large number of applications for the supply of pumps on the hire-purchase system was received. The departmental efforts for the extension of vegetable cultivation have been very successful. Amateur middle-class gentlemen are taking an increasing interest in vegetable gardening. During the year under review, 155 gentlemen in the Upper Assam Valley, twenty-four in the Lower Assam Valley and forty-two in the Surma Valley took to vegetable gardening. Fruit farming is also becoming very popular. Work in the hills consisted of the popularisation of fruits and vegetable farms and improvement of *jhuming*.

In SIND, there has been a considerable increase in the activities of extension and propaganda service on account of the appointment of Deputy Directors of Agriculture, the reorganisation of the district demonstration work and the introduction of new mehods of publicity. During the year under report, five Farmers' weeks were held in the *kharif* and *rabi* seasons at the auxiliary farms on the Right Bank

and six on the Left Bank. The attendance at such weeks was most satisfactory inasmuch as more than 30,000 people visited the farms during both the seasons. The most outstanding work in the rice areas on the Right Bank was the demonstration of early transplantation of rice, *i.e.*, by the month of May instead of July which has been the practice in vogue. Demonstrations of early transplanting have clearly shown that a much higher yield of grain can be obtained and the Barrage water can be spread over a larger area by adopting this method. Zamindars are beginning to follow this recommendation. A demonstration on the value of a reduced seed-rate for wheat was also very successful. The cultivation of linseed was introduced for the first time during the year under report and the results indicate that it has a future. On the Left Bank, harrowing of the wheat crop after irrigation was demonstrated to show how soil moisture could be conserved and the number of waterings applied to wheat be reduced. Considerable progress was made under the cotton extension scheme sanctioned by the Indian Central Cotton Committee to extend the cultivation of improved varieties of cotton in the Barrage areas in Sind. The special feature of the work was the establishment of an organisation for the separate ginning of *kapas*, marketing of growers' produce and multiplication and supply of pure seed. On the Left Bank a remarkable increase has taken place in the cultivation of improved cotton varieties evolved by the department, *viz.*, Sind-Sudhar and Sind N. R. varieties. During the year under report, the Sind-Sudhar variety occupied 200,000 acres and Sind N. R. an equal area as compared with 120,000 and 170,000 acres last year. The work of laying out demonstration plots on zamindari lands for the purpose of demonstrating improved varieties of cotton and improvement in the technique of cultivation was continued. In all, eighty-four centres were selected for such demonstration during the year. A striking feature of the work done on the Right Bank during the year under report is the conversion into cotton tracts of several areas which formerly grew rice.

This has solved many irrigational and economic difficulties. On the Right Bank the total area under cotton during the year was 55,000 acres as compared to 42,000 during last year.

In the NORTH-WEST FRONTIER PROVINCE, the method of demonstration and propaganda included the issue of fortnightly letters in simple language, giving to district officials and important zamindars the main lessons which the department wants to demonstrate and the issue on loan of improved implements, seeds and manure on the condition that cultivators follow the advice of the department. The number of letters issued during last year was 1,000.

In HYDERABAD, aided farms and demonstration plots were laid out in many villages. Demonstration and propaganda work controlled by district agricultural officers is at present being done in fourteen out of the sixteen districts of the State. There were 2,967 demonstration plots in the State during the year under report as compared to 2,649 during last year. Red Hairy caterpillar and Castor Semi-looper campaigns were undertaken during the year. The former insect is a very serious pest and eats up the young seedlings of practically all the dry land crops, while the latter does considerable damage to the castor crop. During the year the Government started a scheme of opening rural development centres in all districts under the guidance of the newly constituted Rural Reconstruction Board.

In MYSORE, a proposal has been submitted to Government for increasing the number of district officers and the number of ranges of Agricultural Inspectors. The aim is to have, in course of time, one inspector and one depot in each taluk as financial conditions permit. The number of demonstrations carried out by the Department was 1,080 as compared to 900 during last year.

In BARODA, the two-fold method of demonstration, *i.e.*, (i) intensive attacks made on a limited objective and (ii) extensive attacks covering a wider field of operation by the use of fully equipped itinerant carts, was continued with increased vigour. During the year under report, 240 villages were given attention.

In thirteen villages in Mehsana, intensive propaganda of sulphur-dusting to protect Cumin from mildew was done thrice. The demonstration was most convincing. Another example of good work was at Petlad where thirty-six Hyderabad ploughs, demonstrated for the first time, were sold in less than four months. The cotton stump-pulling campaign has been most actively pursued. Over 4,000 pullers were sold in the Baroda district and over 1,500 in Navsari, there being an increase of 300 per cent on the last year in the latter district.

In TRAVANCORE, during the year, 113 manurial demonstrations on paddy and 104 manurial demonstrations on coconuts were conducted in different parts of the State as compared to eighty-five on paddy and 102 on coconut during last year.

In COCHIN, demonstrations were carried out on the ryots' own lands by their own labour. That this method has proved useful is evidenced by the large number of applications made by ryots in different centres offering their lands for demonstration. New centres of demonstration were considered during the year since the six years period of the existing centres was completed in some cases. Other demonstrations included the picking of palm beetles from coconut gardens, manuring and spraying grafts, manuring and spraying for leaf disease in coconuts, winnowing experiments against the attack of rice hispa, etc. The requisitions of the public for technical help in the matter of manuring, spraying and eradication of pests were readily complied with.

2. Other forms of Propaganda

NEWER forms of propaganda such as the cinema, radio and gramophone are being utilised with considerable degree of success. The cinema as a form of propaganda is capable of great development but it has its own limitations in India. Few provinces can afford to have an institute of their own and the need for the development of this industry at a central institute which would take the work of producing agricultural films has been stressed by almost all the provinces. The gramophone is

losing ground in favour of the radio and the magic lantern in favour of the cinema. The radio is capable of considerable development provided the broadcast programmes are arranged to suit the requirements of the rural public. The establishment of a number of central radio stations such as at Lucknow, Peshawar, Lahore, etc., has given a fillip to this form of propaganda. Another form of demonstration suited to rural areas is the use of motor vans equipped with magic lanterns, gramophone records and samples of improved crops, manures, etc. These mobile units have been used in connection with the rural uplift programme undertaken by various provinces. The extent to which newer methods were employed in different provinces is mentioned below.

In MADRAS, it is proposed to purchase suitable cinematograph and projection equipment and arrange for the production of films for propagation and demonstration to replace the exhibition vans.

In BOMBAY, rural uplift vans in the South Central Division, North Central Division and Southern Division were equipped with materials for agricultural propaganda in connection with better farming methods in these tracts.

In BENGAL, District Agricultural Officers gave 300 lectures to cultivators either with or without lanterns or with cinema parties touring in their districts; the number of cultivators attending was very large.

In the CENTRAL PROVINCES, the demonstrations by the Manchester lorry were very much appreciated by the public and there was a constant demand for it specially during fairs and shows. Two additional Commer lorries have been purchased to meet the present demand. These are fitted up with cinema engines and accessories. Illustrated lantern lectures were given in 213 centres and cinema lorry demonstrations held at thirty-five places in the Western Circle. It is hoped that one special lorry for the cotton tract will be ready for demonstration work by the end of the year.

In SIND, magic lantern shows were arranged at shows and other important gatherings. In addition, a touring propaganda party has been organised which tours throughout the whole district in the cold season. This party is equipped with a portable magic lantern and slides illustrating the work of the agricultural department and with exhibits of seeds of improved varieties of crops, manures, etc. The touring party started its work in the beginning of 1936 and continued its operations till the end of 1937. In all, the party visited sixteen centres in the Larkhana district, ten centres in the Upper Sind Frontier district and twenty-nine centres in the Hyderabad and Tharparkar districts.

In the NORTH-WEST FRONTIER PROVINCE, frequent talks on agricultural and animal husbandry matters were broadcasted from the Peshawar transmitter.

In HYDERABAD, nine talks were broadcasted by the various officers of the department from the Hyderabad Broadcasting Station.

In BARODA, the itinerant carts consisted of specially designed bullock carts with Dunlop wheels and operated in the Baroda, Mehsana and Amreli districts. In Baroda they visited seventy-two villages, in Mehsana forty-six villages and in Amreli thirty-one villages and aroused considerable interest and brought the department into touch with thousands of cultivators many of whom realised for the first time that a department working in their interest existed. In COCHIN, formal lectures with magic lantern illustrations were given on various subjects connected with agriculture. Lectures were also given on the microphone at the Irwin Park.

3. Propaganda with the help of the grant for rural uplift by the Government of India

THERE has been a great deal of activity in the rural uplift programme of various provinces. A concentrated drive has been made for agricultural improvement, rural sanitation and hygiene. Particular instances of the improvement which have

been made are the improvement of communications, eradication of pests, co-operative distribution of water, bunding and opening of educational classes.

In BOMBAY, during the year under report the Department of Agriculture continued to take a prominent part in the initiation, organisation and supervision of schemes for rural uplift and village improvement in all parts of the Presidency. In the North Central Division, particular attention was paid to the distribution of pure seed of improved crops, to the extension of fruit cultivation and protection of lands against soil erosion. In the South Central Division, attention was mainly concentrated upon tree planting, improvement of village sanitation, preservation of farmyard manure and the supply of improved seeds and agricultural implements. In the Southern Maratha country, schemes for the distribution of improved paddy seed and construction of Poona furnaces for *gur*-making and conservation of manure in pits were continued with success throughout the year. In Gujarat, the supply of pure seed of improved varieties of crops, manures and implements at concession rates to the members of the Taluk Development Association was continued. In addition, a demonstration silo is being erected at Sanand and money has been made available for the supply of breeding bulls in the districts. In the Central Provinces, village uplift activities continued, *i.e.*, the digging of pits for the conservation of manure, general cleanliness of the village, advice and demonstration regarding the growing of more profitable crops and more economic methods of cultivation, establishment of village seed-unions to inculcate the spirit of thrift and self-help. A major portion of expenditure was devoted to the construction of tanks, wells and in repairing the existing sources of water supply, repairing of village routes and construction of cause-ways. Intensive village uplift propaganda was conducted in 564 villages of the Eastern Circle and on home farms under court of wards. These places are becoming increasingly useful as demonstration centres and as sources for the supply of pure seeds. In the Western Circle a

comprehensive systematic agricultural programme of propaganda has been drawn up for fifty-nine villages where rural activities are carried out by the different departments.

In the PUNJAB, the work of consolidation of holdings which was started by the Co-operative Department in 1921 was stimulated with the help of the grant obtained from the Government of India. A greater advance has been made during the last two years in the matter of consolidation. In BIHAR, wells were constructed in the Hazaribagh Division and small embankments for the control of hill streams for irrigation of paddy at Ranchi. Communications were improved in this and in the Bhagalpur area. In ASSAM, wells, tanks and bunds were constructed for supply of water to the fields and communications in various places have also been improved. In the NORTH-WEST FRONTIER PROVINCE, communications have been improved and in all important fruit-growing centres, the principle of financial advantages of marketing on a co-operative basis has been taught to the cultivators. *Shora* bone-meal, which is an excellent manure, is supplied at reasonable prices to places within the reach of the agriculturists of the province. Arrangements have been made for installation of a plant to manufacture this manure. In SIND, seed and implement depots have been established and in ORISSA, the greater part of the provincial allotment was devoted to the improvement of rural water supply and village communications.

In HYDERABAD, the actual rural development work was carried out in fourteen villages round about the Patancheru centre, but concentrated attention was paid to six of them for intensive work. A radio receiving set was obtained and taken to the villages in turn.

In BARODA, the policy adopted last year was pursued and a very much more intensive bid was made to establish better farming. Each village has a co-operative society and distribution of a very considerable quantity of seed has been made possible with the help of the department. The usefulness of the work in the eleven villages under intense farming is much more

obvious to-day than it was a year ago and the number of villages under its influence is likely to increase.

4. Agricultural Shows and Exhibitions

AGRICULTURAL shows and exhibitions continued to be held in all the provinces and States as before and varied considerably in size and scope. In MADRAS, there were 297 exhibitions as against 195 in the previous year. A large-scale exhibition was conducted during the Annual Park Fair Celebrations. Two big exhibitions, one at Srirangam during the *Vaikunta Ekadesi* festival and the other at Tiruvadi, were held. An innovation at these exhibitions was the staging of agricultural dramas drawing pointed attention to drawbacks in certain local systems, at the same time suggesting methods to remove the defects.

With a view to give wide publicity to the new farm recently opened at Pattukkottai and to acquaint the ryots of the Cauvery-Mettur Project area with the work in progress, an agricultural show was held on the farm when sugarcanes grown in the tract were exhibited. Exhibitions, conferences, *jamabandy* (Revenue account) camps and similar gatherings were taken advantage of for giving 1,210 talks to village folk.

In BOMBAY, large agricultural shows were organised at suitable centres, for instance at Sholapur in January 1937 with an attendance of 30,000 cultivators, at Kondanpur and Poona, at Bardoli and Jalalpore and at Ahmedabad.

In BENGAL, during the year the department subscribed to twenty-eight exhibitions including those at Darjeeling and Chittagong hill tracts. Owing to financial stringency, the Government contribution had to be refused in many cases. The department participated in a fairly large number of exhibitions by sending agricultural exhibits and delivering magic lantern lectures. Very successful exhibitions were held at Rangpur, Suri, Faridpur, Manikganj, Brahmanbaria, Malda and Rangamati. The Joydebpur exhibition, which had proved to be very successful in the two preceding years, was not held during the year.

In the PUNJAB, the department organised a mango and date show at Multan, a mango show at Jullundur and a show for hill fruits in Simla. The number of exhibits in all these shows was large.

In BURMA, participation by the department in public exhibitions was limited by the small amount (Rs. 6,000) available under this head. In the Myingyan Circle, the provision of funds permitted the revival of agricultural shows in the year and three were held. At each of these shows, a special agricultural stall was set up. In addition, smaller exhibits were staged on three festivals in the district. In the Northern Circle, the district staff participated in the Maymyo show at which there was a large number of entries in the flower, vegetable and poultry classes. Departmental exhibits were staged at ten pagoda and other festivals and at four of these, ploughing competitions were held. In the Eastern Circle, the district staff took part in the cattle and produce show held in connection with the Taungdwingyi pagoda festival. In the Arakan Circle, an agricultural produce show was held at Akyab during the all-Arakan Sangha Conference. Two cattle and produce shows were organised in the Kyaukpyu and Sandoway districts. The Southern Circle participated in eight small shows locally organised and set up agricultural stalls at six pagoda festivals. In addition, the staff staged a comprehensive exhibit of departmental activities at the Arts and Crafts Exhibition in Rangoon receiving for this purpose help from all circles of the department.

In BIHAR, the department participated in all the fairs held in the province and assisted these with grants which in all amounted to Rs. 650. These grants were utilized towards awarding prizes to those cultivators who exhibited the best produce resulting from the improvement demonstrated by the department. A small demonstration plot is being maintained in the Sonepur *mela* (fair) grounds and each year an instructive and popular demonstration is held during the time of the *mela*. The activities of all the sections of the department are

exhibited and practical working demonstrations of improved implements and water-lift appliances, *gur* and sugar-making and crushing of sugarcane by power-driven portable crushers are shown.

In the CENTRAL PROVINCES, in the Western Circle the number of shows held during the year was forty-nine. Farmers' days were held in many of the Government Farms. In ASSAM, the department usefully participated in fourteen *melas*, shows and public conferences. The Farmers' days were observed in the Upper Shillong Farm in October. The occasion was graced by the presence of His Excellency the Governor of Assam and was much enlivened by interesting discussions on potato growing, live-stock and sheep breeding, etc.

In SIND, local agricultural shows were held at Pithoro, Ram Dev, Sajan Sawai, Shahdadpur, Kandiaro, Munher, Nawabshah, Tando Bago, Khairodaro and Nithiani. In addition to these, an agricultural-cum-industrial show on a large scale was organised in conjunction with the visit of His Excellency the Governor of Sind. The show was first of its kind in Sind and lasted for a week. His Excellency the Governor presided at the prize distribution. A large number of leading zamindars and *jagirdars* (owners of free holds) visited the show. Agricultural shows were also held at Sujawal and Tatta in the Karachi district and at Usif Shah Ammi Pir and Sehwan in the Larkhana and Dadu districts and they proved very successful. In North Sind an agricultural show was also organised in conjunction with the horse show at Jacobabad from 10th to 19th January, 1937. His Excellency the Governor visited the show. A horticultural section was arranged at each show which created lively interest.

In BALUCHISTAN, for the first time, the Agricultural Department held an agricultural show at Sibi in conjunction with the Annual Horse and Cattle Show. The show was a success. A similar show was held at Usta which was well attended. At this show, the Agricultural Officer gave a discourse on general cultivation and the Assistant Entomologist a talk on control

of the black-headed cricket (the *tid*). These lectures were organised under the Presidency of the Assistant Political Agent and the Colonization Officer and were very well attended. Various types of implements and farm machinery were exhibited and demonstrated. Ploughing competition attracted much attention.

The HYDERABAD department participated in the United Provinces Agricultural and Industrial Exhibition held at Lucknow from December 1936 to February 1937, where agricultural exhibits were displayed in a special pavillion. An agricultural show was arranged in February 1937 in the exhibition which was held at Hyderabad on the occasion of the Silver Jubilee of His Exalted Highness the Nizam. The sixth Horticultural and Poultry Show was held on 20th January 1937. A rural development exhibition was held at Patancheru in March 1937. The number of small shows during the year amounted to fifty-eight and the number of lectures given was 154. The agricultural drama ' Premi Kisan ' was staged at the Horticultural and Poultry Show.

In TRAVANCORE, in connection with the birthday celebrations of His Highness the Maharaja, an all-India Agricultural and Industrial Exhibition was organised at Trivandrum. The department took a very active part in this show and occupied one of the largest stalls in the fair. A new line of exhibits at this show consisted of potted plants of both common and rare crops many of which were bearing fruits. Among other exhibitions in which the department participated during the year, mention may be made of the exhibition at the Martandom Rural Centre, the Vavubeli exhibition at Kuzhithurai and the Y.M.C.A. exhibition at Chengannoor, the exhibition in connection with Co-operative Conference at Parur and the Teachers' Conference exhibition at Shertallai.

In COCHIN, the department took part in three exhibitions conducted by the people of the State, *i.e.*, the Rural Cattle Fair and Agricultural Exhibition at Kattakampel, Swadeshi Exhibition at Kolinjampara and the Agricultural and Industrial

Exhibition at Mulanthuruthy. The exhibits were very much appreciated by the public and there was a good sale of plants. At INDORE, twelve *melas* were attended by the Extension Officers of the Institute and at ten of these a cinematograph show was staged. In addition to the display of exhibits, demonstrations were given on *gur*-boiling by the Sindewahi furnace, composting, and eradication of *kans* (*Sachharum spontaneum*) grass.

5. Agricultural Associations

HERE mention is chiefly made of all types of non-official bodies which play an increasing part in the agricultural extension work of provinces and States. In MADRAS, three associations were formed for general agricultural improvement in the Rajahmundry division of the I circle and one for the supply of milk. The Tanjore Delta Mirasdars' Association continued to issue its journal. The annual agricultural exhibition at Srirangam was held as usual by the Trichinopoly District Agricultural and Industrial Association. The Agricultural Improvement Society at Melur in the VI circle maintained more than one hundred acres under cotton seed farms. The Agricultural Association at Palghat organized an agricultural exhibition and financed its members for the purchase of green manure seed. The District Economic Councils, started during the year, helped to bring the existence of the agricultural department to the notice of ryots although no grant has been earmarked for work directly connected with this department. A fair amount of work was done with the help of co-operative societies. A groundnut warehouse at Villupuram, a sale society at Kanjeeveram and a co-operative marketing society at Sriperumpudur—all in the IV circle—were started. Ten co-operative societies in the V circle acted as agents of the ryots for the supply of their requirements of seed, manure, etc. The society at Madura distributed over 10,000 lbs. of Cambodia and Karunganni seed. The Tiruppur Co-operative Trading Society continued its work in seed multiplication of Co2

Cambodia cotton. A large number of other societies, which co-operated in agricultural development in the VIII circle, concerned themselves with the improvement of cotton.

In BOMBAY, the organisation of gun clubs for the protection of cultivators' crops against damage by wild animals made great progress, specially in the Southern Division where over 85,000 acres of crops were protected by these organizations. In the Southern Division two more gun clubs were organized during the year making a total of seventeen. 575 wild pigs were killed during the year. The number of Taluka Development Associations was 102 at the close of the year 1936-37.

In BENGAL, the District Agricultural Associations in the Presidency and Burdwan Divisions became practically defunct after the stoppage of the Government contribution. The Midnapore District Agricultural Association, however, still maintains two small farms at Jumna and Lalgarh, while the Howrah Association continues to publish its magazine. The District Agricultural Association, Burdwan, distributed seed worth Rs. 100. A member of the District Agricultural Association, 24-Parganas, gave a donation for the running of a small demonstration farm on the Bogra system at Atharabanki and another member helped in introducing *aus* paddy in the saline tracts of the Sunderbans. The Rangpur District Agricultural Association spent about Rs. 300 towards the repair of the Nilphamari seed store, while the Naogaon Agricultural Association continued to run its farm. There is no Agricultural Association in Eastern Bengal. A Rural Reconstruction Society has been formed at Brahmanbaria (Tippera) where a farm has been opened and a demonstrator entertained. The Society has further purchased an engine and a pump at a cost of Rs. 3,000 for the irrigation of *boro* paddy.

In the PUNJAB, the Provincial Co-operative Fruit Development Board has now appointed an Assistant Secretary who works in close contact with the Government Fruit Specialist. The Board has done useful work during the year and its various sub-committees have been active. One of the principal

matters under its consideration was the establishment of a properly run wholesale fruit market at Lahore. The total number of Village Farmers' Associations had increased to 3,129 from 2,600 in the previous year. The Agricultural Associations continued to function as in the past years, but whereas formerly they were confined to district headquarters in many districts there are now Tehsil Branch Associations where meetings are held in turn. By this means the membership of the Associations has increased considerably and many people who formerly were unable to attend meetings at district headquarters are now able to derive benefit from the lectures and discussions on various aspects of farming which take place at these meetings.

In BURMA, an important event in the agricultural year under report was the setting up of the Rice Export Trade Enquiry Committee. This was foreshadowed in the address of His Excellency the Governor to the Legislative Council in August 1936 when he announced his intention to call a conference of representatives of the agricultural department and of growers, millers and merchants to examine the policy of the agricultural department in the improvement of the quality and yield of paddy and to advise the Government regarding the scope and requirements of the present-day markets. The Committee held eight meetings and carried out an exhaustive survey of the requirements of the different markets and examined suggestions put forward for meeting competition in these markets. The Committee expressed gratification at the Government's decision to put rice research on a permanent basis and finance it from the provincial revenues after the expiry of the five years' grant from the Imperial Council of Agricultural Research.

In BIHAR, a number of central bodies and co-operative societies continued to take active interest in the discussion of agricultural improvement amongst their society members. The new cane growers' co-operative societies were particularly active in this direction. The provincial agricultural association continued to publish its journal, the *Kisan*.

In the CENTRAL PROVINCES, in the Southern Circle, Tehsil Agricultural Associations were being re-organized. Only those who are really interested in agricultural improvement are encouraged to become members. The Nagpur Orange Growers' Association, registered in February 1936, made steady progress. The share capital at the end of the year was Rs. 3,225 and membership eighty. Government has rendered assistance by placing at the Association's disposal the services of an Agricultural Assistant to organise and carry out the Association's programme and by granting *taccavi* loans to growers for better cultivation. In the Eastern Circle several new development schemes have been put into operation during the year under report, prominent among those being (i) the formation of co-operative cattle-breeding societies and (ii) the organization of Producers' Associations with a view to creating better marketing facilities in co-operation with the Central Boards. The formation of a Producers' Association at the headquarters of each district has as its immediate objective, bulk marketing of improved varieties of paddy. Each association is being provided with a storage godown, out of the Government of India grant. The number of seed unions was 286. The policy has been to consolidate the existing unions rather than to increase their number. The Baghmarra Union continued to show very commendable enterprise and has solved the problem of idle time by extensive introduction of new crops which have increased the income of a village by at least Rs. 4,000. In the Western Circle during the year, the Mehkar Taluq Agricultural Association working in close co-operation with the Verum growers, accepted their seed for storage, gave them substantial advances and sold the seed at a profit at sowing time to the financial advantage of all concerned. There were twenty-three Taluk Agricultural Associations and twenty-four Agricultural Societies working in the circle.

ASSAM. The organization of agricultural associations continued with great vigour in the Upper Assam Valley. Altogether eleven societies were organized during the year and

were affiliated to the District Agricultural Association, Jorhat. In the Lower Assam Valley most of the co-operative societies are playing this part. There were 119 honorary correspondents during the year under report against 117 of the previous year. Out of these, sixty were in the Surma Valley, two in the Khasi and Jaintia Hills and the rest in the Assam Valley: including one each in the Garo hills and the Sadiya tract. The honorary correspondents arranged demonstration on their own holdings and helped the department in other ways as well. The number of progressive middle-class farmers in the province has been fast increasing. 155 such middle-class farmers have undertaken farming in Upper Assam Valley, twenty-four in the Lower Assam Valley and forty-two in the Surma Valley. Besides the farms run by this class, a good number of seed nurseries have also sprung up, and the progress made by them under the direction of the department is quite satisfactory.

In SIND, during the year under report, the second meeting of the Provincial Board of Agriculture in Sind was held at Karachi on the 26th and 27th October 1936 under the chairmanship of Diwan Bahadur Hiranand Kher Singh, Adviser to His Excellency the Governor of Sind. The Board passed a number of resolutions pertaining to different aspects of agricultural improvement in the province. With a view to ensure close co-operation in agricultural matters between officers of the Revenue, Public Works and Agricultural Departments and non-officials, district agricultural committees which meet twice a year have been formed with the approval of the Government. The Collector of the District is the Chairman of the Committee. The members discuss matters regarding the welfare of the cultivator and his requirements and the programme of work is laid out for each district. These committees have achieved very encouraging results and non-official members have shown great interest not only in bringing to the notice of the committee their difficulties for consideration but in actually following the advice given by the official members.

In HYDERABAD, the village improvement association of Patancheru continued its useful work under the guidance of the centre in the way of improving the drainage of the village, providing bore holes, laterines, digging of proper manure pits, repairing of wells, etc.

The Hyderabad Farming Association continued to do useful work and has been issuing its quarterly magazine, *The Hyderabad Farmer*, in three languages. Co-operative Cotton Sale Societies, the object of which is to help growers of cotton to realise the proper value of their produce by selling their cotton on their behalf after classifying it into proper grades, continued to function and earned some profit again this year both at Raichur and Nanded and at a few other places. Co-operative Implement Sale Societies at Parbhani continued to function satisfactorily though the profit was not so large as during last year.

In TRAVANCORE, the officers of the Agricultural and Co-operative departments continued to work in close co-operation. The Agricultural Inspectors freely availed themselves of the help of the Co-operative Societies in the choice of sites for manurial and other demonstrations. In the area chosen for intensive propaganda they organized ryots into agricultural societies on co-operative lines. Several Co-operative Societies continued to maintain their connections with the Department as agents for the sale of manures. The Agricultural Inspector, Trivandrum, organized in collaboration with the Co-operative Inspector for non-credit work, several societies for dairy farming.

6. Seed Multiplication and Distribution

THE arrangements for the production and multiplication of seed of improved crops were extended and improved in several provinces. The Indian Central Cotton Committee continued its policy of helping the agricultural departments and co-operative sale societies in the more extended distribution of pure seed of improved varieties of cotton. The year

under review began with twelve seed distribution and extension schemes. In addition to these, two new schemes were sanctioned during the year for the maintenance of nuclei of pure seed of approved varieties of cotton in Bombay and Sind. Hybridized seeds of half a dozen combinations were sent from Coimbatore to sub-tropical stations in Northern India and over 5,000 seedlings to Karnal for trial. Over one hundred individual packages of canes representing about forty varieties were sent to about thirty places in India and nearly twenty-five post parcels to foreign countries. An account of the various seed distribution and extension schemes is given in paragraphs under each province.

MADRAS. The strain Co 2 (of Cambodia cotton) continued to be popular. In all 249,355 lbs. of seed of this strain were distributed during the year for seed purposes, for nearly 148,000 lbs. of which the VIII circle alone was responsible. The Tiruppur Co-operative Trading Society also produced a large amount of seed of this strain and distributed it in and outside Coimbatore district. In the VIII circle it is estimated that 1½ lakhs of acres are now under this strain. In Madras 206,550 acres were under this strain as against 213,339 in the previous year.

Karunganni cotton. It is estimated that 165,440 acres were under this cotton as against 182,255 acres during last year.

'Westerns' cotton. 148,087 pounds of seed were distributed as against 69,520 lbs. during last year. This cotton is confined to the III circle, N 1 being the strain under distribution.

Of coconuts, 13,390 seed coconuts and 8,202 seedlings were supplied. The seed of groundnut was distributed to the extent of 22,793 lbs. out of which strain AH 25 alone was 10,223 lbs.

In paddy, arrangements have been made whereby ryots go straight to the seedsmen instead of applying to the demonstrators for seed. This method has resulted in developing large quantities of good seed without much expense to Government.

The total area under improved strain (GEB 24) in the province including natural spread is estimated to be 1,395,043 acres as against 1,277,583 acres in the previous year.

The total quantity of seed potatoes distributed in various circles amounted to 69,047 lbs.

In sugarcane, the total area under improved varieties in the province is 42,650 acres, as against 39,597 acres in the previous year.

In BOMBAY, there were six organised seed distribution schemes for improved varieties of cotton in force in the province. In all the schemes financial assistance was given by the Indian Central Cotton Committee.

(a) *Surat seed distribution and extension scheme.* This scheme deals with the distribution and extension of the improved cotton variety 1027 ALF in the Surat district. During the year 2,643,064 lbs. of seed were handled by the department of which 1,086,655 lbs. were distributed through twenty-four seed depots in the Surat district. In addition, approximately 293,946 lbs. of seed of this variety were supplied directly by co-operative cotton sale societies to their members. The seed production area under departmental control and grown with pure 1027 ALF was 25,582 acres.

(b) *B D 8 seed distribution and extension scheme.* This scheme is devoted to the distribution and extension of high yielding wilt-resistant strain of cotton, *i.e.*, B D 8 in the Broach district. From a controlled area of 1,000 acres 456,000 lbs. of seed were obtained together with 615 bales of B D 8 lint. The latter were sold at a premium from Rs. 37 to Rs. 53 per *khandy*. About 200,000 lbs. of seed have been distributed over an area of 20,000 acres.

(c) *Revised Jayawant and Gadag No. 1 seed distribution and extension scheme, Southern Division.* The total area grown with these two cottons during the year under report was about three and one lakh acres respectively.

(d) *Banilla seed distribution and extension scheme, Khandesh.* This scheme terminated during the year under

report as the Agricultural Department has decided with the approval of the Indian Central Cotton Committee to concentrate on the distribution of the improved strain known as Jarila which is superior to Banilla in staple, is much more wilt-resistant and is in general more suitable for the whole of Khandesh tract.

(e) *Banilla seed distribution and extension scheme, Deccan Canals.* During the year under report thirty-one acres of pure Banilla cotton were grown on the Kopergaon Farm and 8,875 lbs. of pure Banilla seed were distributed to departmental registered seed-growers.

Among other crops noteworthy progress was made in the extension of improved strains of paddy in the Southern Division where 24,386 acres of high yielding rice varieties evolved at the Mugad and Kumta farms were grown in Dharwar, Belgaum and Kanara districts. In Khandesh and Nasik districts, the area under improved varieties increased from 4,000 to 15,000 acres and conspicuous success has attended the introduction of improved wheat variety, Bansipalli 808, in Ahmednagar district and the Southern Division and of the improved mid-late rice strain K 540 in Ratnagiri district. In addition, the extension of cultivation of sugarcane, fodder crops, for instance, lucerne, maize, *nilwa*, *jowar*, etc., was assisted by the extensive distribution of setts and seeds of improved varieties in many taluks. One notable feature of this year's work, specially in the coastal tracts, was the increased supply of fruit tree seedlings, pine-apple suckers, mango grafts, etc., to cultivators from the Ratnagiri and Kumpta Farms.

In BENGAL, the Union Board Farms have served a very useful purpose and have been of considerable help in more rapid distribution of departmental seed. The introduction of such crops as English vegetables has also been helpful and proved of value to the cultivators not only from the money obtained from their sale but also as a useful addition to the cultivators' own food. In some cases many spare seedlings of cauliflowers and cabbages were taken by the neighbouring cultivators. The

area under sugarcane has increased from 325,000 acres to 354,000 acres of which 290,000 acres are reported to be under departmental varieties. In tobacco the area has increased by over 25,000 acres during the last four years and is mostly under departmental variety. During the year some 4,000 tolas of seed of recommended *deshi* varieties were distributed from Government farms. The number of paddy seed farms remained the same as last year but in addition much help has been obtained in the distribution of seed by 450 Union Board Farms. This gave an additional 2,000 acres under departmental varieties for future needs.

In the PUNJAB, the stimulus given to the distribution of improved seeds by the Seed Conference, which was convened by His Excellency the Governor in December 1934, continues to gain strength at an amazing pace. During the year the operations of the department in this connection reached a pitch which probably not even the most optimistic member of the Conference would have believed possible. The quantities of pure and improved seed sold to the cultivators by the department during the year under report were:—wheat 220,500 maunds, cotton 71,700 maunds, rice 4,860 maunds and gram 15,900 maunds as compared to 145,000 maunds of wheat, 64,700 maunds of cotton, 3,200 maunds of rice and 10,200 maunds of gram respectively during last year. There has been an extremely rapid rise in the popularity of the two new wheats, *i.e.*, C 591 and C 518, during the last two years. The quantity of these seeds represents fifty per cent of the total wheat seed distributed; the remainder being 8A. The enormous expansion which has taken place in seed-distribution activities has necessitated the appointment of a very large number of commission agents for the sale of wheat seed. The number of such agents was 938 during the year. The importance which Government attaches to the growing of pure seeds of high-yielding quality is shown by the increase made in the budget provision for seed purchase and seed distribution in recent years. In 1932-33 the amount provided was

Rs. 1,77,000; in the year under report it was Rs. 9,20,210 and for the next year it is Rs. 11,50,000. In cotton an area of over 150,000 acres is being grown under two varieties (43 F and L S S) from departmental pure seed alone in the current year. The principal sources of supply of large quantities of seed are departmental farms, large grantee and other estates, particularly in the Lower Bari Doab Colony and seed-producing societies.

In BURMA, over 17½ million lbs. of seed have been distributed during the year—the chief distribution being in rice consisting of 16,415,684 lbs. In cotton (294,788 lbs.) the major part of the distribution has been in the Myingyan circle. 194,400 lbs. of groundnut seed have been distributed chiefly in the East Central circle, the West Central circle and the Northern circle. Sesamum at 24,559 lbs. has been distributed mainly in the West Central circle, Myingyan circle and the East Central circle. Gram distributed during the year amounted to 104,118 lbs. Millet (46,611 lbs.) was distributed mainly in the East Central circle and Myingyan circle, and wheat (39,675 lbs.) mainly in the Myingyan circle. Under sugarcane the East Central circle shows a distribution of just over 3¼ million setts. During the year, grafts and seedlings of fruits were also distributed by the department. These consisted mainly of mangoes, African oil palm, and pine-apples.

In BIHAR, the total area planted with sugarcane was about 493,000 acres as against 447,200 acres in the preceding year; the area under improved varieties being 450,000 acres. The yield of sugarcane crop was not less than 151,203,100 maunds. The total quantity of seed sold in the year was 2,417 maunds of wheat, 1,168 maunds of paddy and 14,143 maunds of sugarcane.

In the CENTRAL PROVINCES, in the Northern circle it is estimated that 633,704 acres were sown with improved seed. The value of the increase in outturn resulting from seed distribution is stated to be Rs. 10,22,800. In the Southern circle, the quantity distributed was 104,869 maunds. In the Eastern

circle, improved seed amounting to 119,423 maunds was distributed. In the Western circle, there was a fall of 38,579 maunds in the quantity of seed distributed, due to a reduction in the demand for Roseum cotton and partly to lesser demand for Verum in the Akola district. On the other hand, the demand for groundnut was usually high due to heavy yields and good prices during the previous year. Although a large number of seed-farmers is registered, considerable difficulty is experienced every year in meeting the demand for pure seed because of the cultivators' habit of selling all their crops immediately after harvest. This problem could be effectively solved by organising growers' co-operative godowns where pure and other seeds could be purchased and issued at the sowing time at a premium. Under the scheme for the extension of long staple cottons and marketing of Verum cotton in the Central Provinces sanctioned by the Indian Central Cotton Committee during the year, the Agricultural Department distributed 5,594 *khandis* of pure seed of long staple varieties sufficient to cover an area of about 117,849 acres as against 4,142½ *khandis* of pure seed distributed over an area of about 103,537 acres during last year. 5,853 *khandis* of pure seed have been stocked for distribution during 1937-38 season. It is estimated that an area of 113,371 acres will be covered by Verum cotton during 1937-38. There is a slight fall in the area due to the low premium obtained during 1936-37 season and unfavourable weather conditions.

In ASSAM, the seed depots at Gauhati, Sylhet and Jorhat were maintained. During the year under report 218,374 lbs. of paddy, 49,938 lbs. of seed potatoes and 388,525 setts of sugarcane were supplied as compared to 117,633 lbs. of paddy, 124,728 lbs. of seed potatoes and 303,761 setts of sugarcane respectively during last year. There was a considerable fall in transactions in seed-potatoes, the sale of which has now been taken up to no small extent by private dealers. The increase in the transactions in paddy seed and sugarcane setts indicated an increase in popularity of seed depots. The sale

of vegetable seedlings initiated and sponsored by the department has now become an established local trade.

In SIND, the Government Auxiliary Farms are playing a most important part in the organised schemes for the multiplication of seed of improved varieties of wheat and cotton. As a result of a grant sanctioned by the Government of India for the rural uplift work, the Local Government established a number of village seed and implement depots in the districts; eighteen seed and implement depots established in February 1936 have been functioning during the year. These have been instrumental in solving many difficulties of the small cultivators in rural areas. During the year under report over 36,000 maunds of pure seed of improved varieties of cotton, wheat, rice, *jowar*, *bajri*, oil-seeds, etc., were sold. The area under cotton in Sind went up to 976,832 (including 63,229 acres in Khairpur State) acres from 790,858 acres during last year, and of this area 568,588 acres were occupied by American varieties and 408,244 by *desi* varieties. The Agricultural Department distributed 14,060 maunds of 4F-98 and Sind-Sudhar seeds on the Right Bank and 21,585 maunds of Sind-Sudhar, 812 maunds of Egyptian and 3,685 maunds of Sind N R on the Left Bank. The Government sanctioned during the year a sum of Rs. 25,000 for the purpose of purchase and distribution of wheat seed in the province and it were further pleased to order that the Sind Provincial Co-operative Bank should be encouraged to do the financing of seed business. Accordingly a sum of about Rs. 18,901 was spent on the purchase of about 6,063 maunds of wheat seed which was sold at a profit of Rs. 112. The rate at which seed was sold to cultivators was cheaper than the prevailing market rate of wheat seed obtainable locally for sowing purposes.

In the NORTH-WEST FRONTIER PROVINCE, out of the two lakhs *taccavi* given every year Rs. 50,000 is allotted to the Agricultural Department for distribution in kind. Seeds, manures, live-stock implements, etc., are distributed.

In the HYDERABAD State, the total area under the improved varieties of sugarcane was reduced to 9,151 acres as compared to 56,938 acres in the previous year. This fall has been due to the reduced price of *gur*. The total quantity of Jayawant and Gadag No. 1 cotton seed distributed during the year amounted to 374,633 lbs. sown over an area of 13,871 acres, against 553,880 lbs. of seed sown over an area of 41,256 acres during last year. The Department of Agriculture organised during the year a seed-multiplication area of 3,000 acres which is expected to yield 285,500 lbs. of pure seed for distribution during 1936-37 season. There is a special staff for the distribution of the Gaorani cotton seed in the Gaorani protected area which works under the Deputy Director of Agriculture, Godavari Division. The department supplied seeds of improved varieties of crops during the year for an area of 70,245 acres. Plants of fruits, vegetables, flowers, avenue trees and ornamental shrubs were also distributed.

In MYSORE, 914,000 setts of sugarcane, 25,369 seers of paddy, 16,888 seers of *ragi*, 9,518 seers of groundnut and 13,090 lbs. of cotton seed were supplied during the year as compared to 16,225 setts of sugarcane, 39,000 seers of paddy, 20,000 seers of *ragi*, and 15,000 seers of groundnut during last year.

In BARODA, under the Baroda (Navsari Cotton Seed Storage) scheme, the total quantity of seed distributed during the year amounted to 314,432 lbs., of which 28,020 lbs. of the best quality seed were issued to "A" class growers for an area of 2,505 acres and 76,628 lbs. of dependable quality seed to "B" class growers for 3,544 acres. The lack of farm-grown seed for supply to "A" class growers has all along been felt to be a weak spot in the Baroda seed organisation and the State has now taken steps to remedy this defect by opening a seed farm of about seventy acres. This area will form the nucleus from which "A" class growers will receive their seed. 447,516 lbs. of seed of dependable quality for sowing in 1937

season have been obtained and it is expected that the whole of this quantity will be disposed of. For the distribution of pure seed Government have sanctioned a proposal for establishing five seed-depots and provided a working capital of Rs. 25,000. In the present year the first step was taken in respect of Pusa 52 in Mehsana and Pusa 4 in Amreli for which fresh stock were obtained from Pusa, the United Provinces and Bihar. Similar steps were taken at the close of the year (1936-37) to create a paddy nucleus round Vyara and an exactly similar organisation will in due course follow for groundnut and other main commodities.

In TRAVANCORE, 6,216 lbs. of selected seeds of paddy were sold to ryots as against 6,889 lbs. in the previous year. In sugarcane P O J 2725 has established well in the State and 21,350 setts of this variety were supplied to the cultivators at a nominal cost of four annas per one hundred setts. From the Paddy Farm at Nagercoil 12,000 lbs. of selected paddy seeds were sold to the ryots. Small lots of cuttings from selected pepper vines were distributed from the Pepper Farm. Seeds of soya beans, tomatoes and other exotic crops were imported from outside and supplied free in small lots to interested ryots. There was a large increase in the supply of grafts, rooted cuttings and other planting material of choice fruit trees from the Fruit Farm, Cape Camorin. The Cocoanut Farms at Oachira and Alleppey continued to devote attention to the collection and sale of selected seed-nuts.

In COCHIN, there are now seed depots in almost all the taluks. As usual, good selected seeds were issued on loan at ten per cent interest in kind per season. 1,045 *paras* of seed were issued to 207 persons as against 1,100 *paras* to 219 persons in the previous year. Small quantities of improved selected strains of chitteni have been distributed in the several taluks for trial and multiplication.

At INDORE, the usual sale of seed was carried on and improved seed other than cotton worth Rs. 1,500 was sold during the year under report.

7. Implements

A STEADY progress is maintained in the introduction of improved implements. In Appendix V will be found a statement of the agricultural implements sold through departmental agencies. These figures, however, are no real measure of the extent to which improved implements are used as a large number of private agencies have sprung up in various provinces which manufacture and sell all kinds of implements. In addition, village blacksmiths are making copies of improved implements locally and making supplies to cultivators direct. It is difficult to record all these figures. Departmental sales in many cases represent only the immediate results of successful demonstrations.

In MADRAS, it is estimated that nearly 3,000 iron ploughs were sold throughout the Presidency during the year. The turmeric polishing machine was demonstrated in some taluks of Coimbatore district and found favour among ryots. The noteworthy event of the year was the sanction by Government of a special grant of Rs. 30,000 for the equipment of depots. This money was utilised for the purchase of different types of implements intended for exhibition and demonstration. There were during the year, 17,891 demonstrations on various implements and machinery as compared to 12,987 during the previous year. Of this over 9,000 demonstrations were with improved ploughs. Demonstrations were also given in rubber-tyred carts in the VIII circle.

In BOMBAY, the Agricultural Engineer to Government dealt with 242 enquiries for advice in connection with the installation and maintenance of agricultural machinery as compared with 189 in the previous year. There was a considerable demand for boring machines and pumping plants on hire. Under the cotton plant-pullers scheme 2,871 plant-pullers were sold in the Broach district and 2,600 in the Surat district.

In BENGAL, the Bengal ploughs have continued to be popular and there has been a heavy demand for these. Tests have

shown their superiority over wooden ploughs in several areas and their use has led to increased yields. Two types of scutching machines for flax were constructed by the Agricultural Engineer and have proved successful in considerably increasing the output. Experiments are being continued for improving their efficiency.

In the PUNJAB, there has been a considerable trend towards the greater use of implements, particularly the ploughs. The Meston plough manufactured in India is still the most popular of the improved ploughs. The total number of Meston ploughs, whether made locally or imported, sold in the province during the year was about 5,000. Hindustan ploughs occupied the second place, their sales amounting to 1,500. Seed-drills were in greater demand than before and cultivators are beginning to appreciate their value.

In BURMA, implement sales for the year show very satisfactory increase of close on sixty per cent over the previous year. In the sales for the year under report, the 13,652 ploughshares distributed compare very favourably with 8,405 of the previous year.

In BIHAR, the total number of implements sold during the year was 2,414 and of spare parts 550. The demand for open borings and small $1\frac{1}{4}''$ and $1\frac{1}{2}''$ tube-wells has decreased, because private enterprises undertaking the work are springing up. *Rahat* pumps are now being manufactured all over Bihar by foundries and *mistries*, and the public is beginning to use them in increasing numbers. The department supplied eight *rahats*, seven archmedian screw lifts and six Norag threshers during the year. Pumping demonstrations were carried out at twenty-four places. In the Tirhut Sub-division alone the cultivators purchased 328 improved iron ploughs, 154 improved hoes and 320 spare parts of these implements.

In the CENTRAL PROVINCES, in the Northern circle, the sale of implements amounted to Rs. 34,454. This year McCormick seed-drills were tried in the Rehli tehsil of the Saugor district for the first time and proved successful. In the Harda tehsil,

7,000 acres were sown with the aid of twenty-seven drills and their use in farm economy has been generally accepted. *Taccavi* loans to the extent of Rs. 17,531 were granted to cultivators for the purchase of improved seed, implements and breeding bulls. In the Southern circle, implements, cane mills, *rahats* and wire fencing to the value of Rs. 60,457 were sold and *taccavi* loans of Rs. 73,998 were recommended for the same purpose. In the Eastern circle, implements and equipment to the value of Rs. 15,563 were sold during the year. Rs. 21,745 were given out on *taccavi* for the purchase of seed, manures, implements and equipment.

In ASSAM, an increasing demand for 3-roller sugarcane mills and shallow *gur*-boiling pans was noticed. The demonstration for introduction of agricultural implements such as the Meston plough, the spring-toothed harrow, etc., could not appeal much to cultivators due mainly to the inability of the local bullocks to provide the necessary power.

In SIND, the institution of village seed and implement depots, established under the village uplift and rural development scheme, has been instrumental in solving many difficulties of the cultivators. Several improved agricultural implements, such as ploughs, Jenkins Clod Crusher, winnowing machines, seed-drills, inter-cultivators, sprayers, rat-killing pumps, etc., are stocked for being made available to the small cultivators either free of cost for demonstration purposes or at low rates on hire. Each depot is located in the business centre of the village. During the year, over 1,000 improved agricultural implements were sold and 1,163 were lent to the cultivators through the village depots. The department lends free of charge for demonstration on the zamindari lands any of the implements stocked in the depots for a period not exceeding fourteen days. A deposit of Re. 1 is taken for cheap implements and Rs. 12 for an expensive one at the time of lending such implements to zamindars. The amount is refunded on the return of implements in good condition and within a specified period of fourteen days. During the year under report, the extension of

the use of improved agricultural implements amongst cultivators has been largely carried out in the villages by a non-official agency of village *mistries*. The demand for the more costly type of implements is still restricted on account of the financial condition of cultivators.

In the NORTH-WEST FRONTIER PROVINCE, a form of low lift pump, very popular in Egypt, has been installed at the Tarnab Farm. It gives sufficient discharge when worked by a single bullock. The Public Works Department has ordered a pump for demonstration on the Paharpur Canal. The Jenkins Clod Crusher and the winnower from Sind have proved the most useful implements. The Sultan Nahan 3-roller mill has proved to be the best. The sugarcane growers in the North-West Frontier Province are using it in large numbers. A Ransom Turn Wrest plough has proved useful. During the period June 1935 to June 1937 there were on an average six rubber-tyred bullock carts in use at the Tarnab Farm. Due to bursts and bulges of the tyres which have become too frequent they have not lived up to their reputation gained in the first year. The department has brought out an improved yoke which consists in fitting to the country yoke where it bears on the bullock's neck a pad of cellular rubber marketed by Messrs. Dunlop under the name of Dunlopillo. Half the bullocks at the Tarnab Farm have been using this yoke for a full year without a single case of yoke-gall being reported.

In HYDERABAD, the department supplied 754 implements and 1,304 spare parts during the year. Improved iron ploughs are popular in Godavari and Karnatak divisions where the cultivators have realised that they are much more efficient in removing deep rooted weeds. The greatest success has been achieved in the introduction of machines and appliances in connection with sugarcane cultivation. There are about 55,509 iron ploughs used at present in the districts. Some manufacturers of agricultural implements have opened agencies in the districts.

In BARODA, a definite bid has been made this year to place at the disposal of cultivators modern implements suited to their needs and to their pockets. After careful trials, certain ploughs suited to the light and heavier soils have been selected. A light hoe secured from the Central Provinces has been altered in design and another rather heavier general cultivator and hoe has been specially designed for effective work under almost all conditions in the State. Steps have been taken to organise an industry for the large-scale manufacture of these two implements at the Syaji Iron Works in Baroda. These implements are now extensively demonstrated. Depots to stock these in number have been opened at Baroda, Vaso, Kalol, Mehsana and Amreli, in several cases the depots being supported by sub-depots. This has been made possible with the aid of Rs. 10,000 sanctioned as business grant. Steps are being taken to create the hire-purchase system of supply also. The number of implements taken up during the year was much in excess of anything hitherto attained in any one year. In 1935-36 the total did not exceed fifty, whereas in the year under report sixty-one heavy ploughs, eighty-one light ploughs and 102 cultivators and hoes were purchased; thus making a total of 244 modern implements as a result of three to four months of propaganda. Under the plant-puller propaganda scheme, over 4,000 plant-pullers were sold in Baroda district and over 1,500 in Navsari, there being an increase of 300 per cent on the last year in the latter case.

In MYSORE, 512 ploughs, 4,007 spare parts, sixty-one cultivators and forty-five sugar mills were sold during the year. In TRAVANCORE, the department continued to pay special attention to the popularisation of light iron ploughs. The working of Climax and Meston ploughs was demonstrated in many places. The Pallikkal plough, which is an imitation of those made by local blacksmiths, has won greater favour among cultivators. A large number of garden tools is also kept in stock by all agricultural inspectors and their use is freely demonstrated to the ryots within their jurisdiction. Many of these

are being regularly manufactured in the villages. The small engine and pump and the 3-roller sugarcane mills were demonstrated on the Alwaye Farm.

8. Fertilisers

APPENDIX VI gives the sale of fertilizers through departmental agency. There has been an increased activity in the manufacture of compost and the use of green manures wherever possible. Imports of chemical fertilizers amounted to 83,653 tons in 1936-37 as compared to 72,210 tons in 1935-36. This included in 1936-37, 61,238 tons of ammonia sulphate, 2,064 tons of muriate of potash, 6,009 tons of superphosphate and 4,122 tons of ammonium phosphate. Indian production of ammonium sulphate during the year amounted to 17,748 tons compared to 17,851 in 1935-36 and the approximate consumption of ammonium sulphate to 76,360 tons as compared to 57,164 tons in 1935-36.

In MADRAS, the presence of sugar factories has augmented the use of chemical manures either pure or in combination with organic manures. Phosphatic manures like bone-meal, Trichy phosphates and fish guano were recommended for application in combination with green manures. A special manure mixture for potatoes was recommended by the department and many firms took advantage of the advice of the department for preparing such mixtures. Chemical manures were reported to have been applied over an area of 43,722 acres of paddy and 10,270 acres of sugarcane. Propaganda on proper conservation of cattle manure was continued. The number of manure pits maintained in all the circles under different methods during the year under report was 37,799 as compared to 28,586 during last year. Some municipalities are interesting themselves in the conversion of night-soil into poudrette. The Karur Municipality issued free manure made from composts to selected ryots for trial. In the VII circle, water-hyacinth, a pest under the Madras Agricultural Pests and Diseases Act, in Palghat and Ponnani taluks was composted into manure. The total number

of compost made during the year was 1,792 as against 1,683 in the previous year.

Dhaincha, sunn-hemp, wild indigo, indigo and cow-gram were recommended as suitable crops for green manuring with the result that 129 tons were sold by the department, while other agencies disposed of 270 tons.

In BOMBAY, the district staff of the department has been concentrating upon the improvement of village manure supplies by the introduction of better methods of conservation and of compost manufacture. This work has now been taken up by the public in several areas. The Imperial Chemical Industries have organised a network of agencies all over the North Central Division and effected a large sale of commercial fertilisers among which sulphate of ammonia is widely sold. The Taluk Development Associations are their distributors in several places. About 735,597 lbs. of sulphate of ammonia was sold in the division. Oil-cake is used for irrigated crops and for cotton.

In BENGAL, the Union Board Farms have been helpful in distributing manures. The use of fertilisers is steadily increasing, but is still a long way behind some of the other provinces.

In BIHAR, in the Tirhut Division alone cultivators purchased 2,296 maunds of oil-cake and 870 maunds of chemical fertilisers for manuring their crop. In South Bihar and particularly in Patna Division 48,139 maunds of ammonium sulphate for manuring sugarcane, potatoes and other cash crops and 13,507 maunds of gypsum for manuring paddy were purchased by cultivators. In all, 2,789 maunds of artificial fertilisers, 3,240 maunds of cake and 16,569 maunds of gypsum were distributed amongst cultivators during the year under report.

In the CENTRAL PROVINCES, the value of artificial fertilisers is now appreciated by the cultivators. During the year under report, in the Northern circle alone 5,512 maunds of ammonium

sulphate and Nicifos were sold on *taccavi*, chiefly in the Bhandara and Balaghat districts.

In ASSAM, the popularisation of locally available manures received greater attention than commercial fertilisers. The preservation of cattle-dung, the utilisation of water-hyacinth ash and the preparation of compost were demonstrated in a number of centres. In addition, manurial demonstrations on some crops were conducted successfully in many places. This has created some demand for such manures as ammonium sulphate, oil-cakes, water-hyacinth, sodium nitrate, and Niciphos. The three seed-depots at Gauhati, Sylhet and Jorhat continued to supply manures for demonstration as well as for sale to the public at reasonable prices. The sale of bone-meal, initiated by the Department of Agriculture, has now become an established local trade in some places.

In SIND, the Agricultural Department carried on intensive propaganda work to bring to the notice of the cultivators the value and importance of green manuring, and a series of green manure crop demonstrations are organised annually in both *kharif* and *rabi* seasons on zamindari lands in all districts. Government have made liberal concessions by foregoing assessment if certain crops are grown for manure and have at the same time allowed one cutting to be taken for fodder. The concessions have been made available for a further period of two years ending with the *rabi* season of 1937-38. A series of experiments with different chemical fertilizers were carried out during the year in conjunction with private commercial firms, *e.g.*, the Imperial Chemical Industries, Ltd. These experiments are mostly carried out on cotton, wheat and rice.

In the NORTH-WEST FRONTIER PROVINCE, the department has been manufacturing bone-meal manure by grinding bone and mixing it with twenty per cent of local saltpetre and selling it at Rs. 2-6 per maund. After keeping the mixture for three months 90 per cent of P_2O_5 is converted to citric soluble form.

An important discovery is the value of the *shora* bone-meal manure in combination with farmyard manure. One cwt. of *shora* bone-meal replaces two tons of farmyard manure. In addition to *shora* bone-meal the department is also manufacturing a manure made by mixing quick lime and blood in equal proportions. The blood dries up quickly without any offensive smell. The zamindars have so far shown little inclination to buy the manures the department is selling.

In HYDERABAD, castor cake and groundnut being available locally are being pushed by the department and their use is increasing gradually. Ammonium sulphate is recommended to sugarcane growers. Nicifos is recommended for manuring paddy in addition to some farmyard manure and castor cake. Its use is extending gradually. Artificial fertilizers and manures were sold for an area of 1,469 acres through the departmental agency of the Imperial Chemical Industries. This does not include the quantity sold by the firm direct to the cultivators. Demonstration of compost cake was continued in aided farms and on other lands in villages.

In MYSORE, the seed of green manure crops was distributed to the extent of 5,769 seers during the year under report.

In TRAVANCORE, at Trivandrum only private firms and other agencies sell manures within the State, the most important being the Imperial Chemical Industries. Manures to the aggregate value of Rs. 81,846 were sold during the year. Another local concern, in addition, sold manures to the value of Rs. 4,865. There were in all seven co-operative agency manure depots working during the year. The total sale from all the depots amounted to Rs. 894. Several of the municipalities in the State adopted the process of compost-making recommended by the department for the conversion of night-soil and street-sweepings into good manure. The Agricultural Inspectors simultaneously carried on vigorous propaganda to popularise manures among cultivators. The Quilon Munici-

pality was the first to take up this work and sold compost to the value of Rs. 2,000. The demand was far in excess of the supply.

In COCHIN, there are manure depots in almost all the taluks. Representative collections of all the manures are stocked in the depots, the quantities varying according to the requirements of the people. Very large quantities of manure were sold to the cultivators from these depots.

CHAPTER XIII

AGRICULTURAL EDUCATION

1. Agricultural Colleges

DURING the year there was an increased demand for admission into the agricultural colleges at Coimbatore, Lyallpur and Nagpur. At Lyallpur, the number of students at the College beat all previous records. Two new institutions, *i.e.*, The Basanta Kumar Agricultural Institute at Rajshahi (Bengal) and the Seth Dosabhai Magan Lal Agricultural Institute on the Baroda Farm, have been started for imparting agricultural education of a slightly higher standard than that given in schools. With the spread of the rural uplift movement and the general awakening of interest in the subject of agriculture, a large number of young men are now being attracted to an agricultural career.

MADRAS. There was an increase in the number of applications to the Agricultural College, Coimbatore, this year. 156 applications were received as against 116 and 91 in the two previous years. The number of fresh admissions was 47. Thirty-six students appeared for the final year B.Sc. (Agri.) examination and 28 passed. Thirteen special lectures were given to students by various research officers during the year and students of the second and third year classes were taken out on tours to different stations in the province and to Mysore.

BOMBAY. The number of students who attended the Agricultural College, Poona, showed no diminution. The new curriculum at the College is now in full force, the first batch of B.Sc. (Agri.) students passing out during the year under report. The last examination for the old B.Ag. degree was held during the year. The Agricultural Graduates Employment Bureau, which is maintained at the college in order to assist agricultural graduates to find suitable employment at the end of their

college careers, had 94 registered subscribers on its rolls, including 10 new subscribers added during the year. Fourteen enquiries were received from employers and were circulated among subscribers.

BENGAL. No further progress towards the realization of the scheme for the establishment of the Dacca Agricultural Institute was made owing to lack of funds. The Basanta Kumar Agricultural Institute was started at Rajshahi out of the assets of the endowment fund created by the will of the late Mr. Basanta Kumar Roy. Provision has been made for training two classes of students:—(i) casual and (ii) regular students. The former are generally students who along with their studies in the college classes at Rajshahi or elsewhere, join the Institute for such vocational teaching—both practical and theoretical—as may be available—while the latter will be those who are whole-time students of the Institute.

PUNJAB. There has never been such a desire for an agricultural education of the degree standard as exists at present. The most pleasing feature is that it comes from the cultivating classes more than ever before and that the type of student seeking it has greatly superior educational qualifications than their predecessors in recent years. Of the 350 students seeking admission, selection had to be limited to eighty-two owing to lack of hostel and laboratory accommodation. Of those admitted, eighty-two per cent were statutory agriculturists and not a single student, now attending the first year class, is less than a second division matriculate. The total number of students who attended all classes was 565 which constitutes a record in the history of the college. The previous record was 447 in 1931 and 1936. Of the 565 students, those taking the degree course number 260; the remainder attended the dozen or so other courses of various durations from two weeks to two years. Four students were admitted to the M.Sc. (Agri.) class this year. Out of fifty-five, thirty-five students passed the final B.Sc. (Agri.) examination. In the qualifying subjects of agricultural engineering and veterinary hygiene, thirty-seven

students appeared for the examination and thirty-three and thirty-four respectively passed. Of the fifteen students who appeared for the examination of the College Leaving Certificate, eleven were successful.

CENTRAL PROVINCES AND BERAR. The number of applications (157) for admission during the year to the College of Agriculture was unusually high. Sixty-two candidates were called for interview and fifty-eight were admitted. Twenty-three appeared for the final B.Ag. degree examination and fifteen were successful. Students of the 4th year toured during the year in Chhattisgarh and the northern districts.

ASSAM. During the year under report two stipendiary students were sent to the Allahabad Agricultural Institute—one for the Agricultural and the other for the Indian Dairy Diploma course.

NORTH-WEST FRONTIER PROVINCE. The Islamia College is now teaching agriculture up to the B.Sc. standard. The number of students in the year under report was seventeen in the first year and three in the final year. From the first batch of five students who appeared at the B.Sc. (Ag.) examination in 1937, four passed.

HYDERABAD. One scholar of the department returned this year after completing his course at the Nagpur Agricultural College. Three scholarships were granted this year. Eight scholars are at present studying in the Nagpur, Poona and Cawnpore Agricultural Colleges.

BARODA. The most interesting episode was the opening of the Seth Dosabhai Maganlal Agricultural Institute erected at a cost of Rs. 2,000 donated by his widow. The Institute is on the Baroda Farm and was opened in February, 1937. Twenty-five students were admitted out of an application list of one hundred.[1]

2. Post-graduate training in Agriculture

The Imperial Agricultural Research Institute, New Delhi. The post-graduate courses beginning in November, 1936,

attracted a record number of sixty-eight candidates of whom thirty-six were recommended by provincial authorities for nomination of students. Seventeen applicants were selected for admission, four in Botany, five in Agricultural Chemistry, two in Entomology, one in Mycology, three in General Agriculture and two in Sugarcane Breeding who were instructed to join the Sugarcane Station at Coimbatore. Of the fifteen fresh men admitted at Delhi, two, one each in Agricultural Chemistry and Botany, left after the first term on getting appointments. During the year under report eight post-graduate students successfully completed the two-year course and qualified for the Institute diploma: three in Botany, three in Agricultural Chemistry, one in Entomology and one in Mycology. The one-year course in farm organization and general farm engineering was completed by three students.

In addition, three employees of the Agricultural Department in Baluchistan, one of the Assam Agricultural Department and one of the Sind Agricultural Department were given training for various periods. A nominee of the Director of Agriculture in Sind and a private candidate from the Punjab University were also admitted as short-course students. Five post-graduate students of the Imperial Dairy Institute, Bangalore, were given facilities for studying the work done at the Institute and its sub-station at Karnal.

3. Agricultural Schools

In many provinces a greater interest was manifest in school education in Agriculture.

Madras. The school at Usilampatti continued to be under the management of the District Board, Madura. Twenty-six students underwent training during the year. The District Board is contemplating the amalgamation of the middle school with the Board High School, Usilampatti and orders of Government on the proposal are awaited. The three schools at Anakapalle, Palur and Coimbatore continued to function during the year with day and night classes at Anakapalle and with

day classes alone at Palur and Coimbatore. At Anakapalle, there were twenty-five boys on the rolls during the year as against twenty-four of last year. There were twenty adults in the night school. At Palur there were thirty-one on the rolls as against twenty-eight last year. The night school was closed under the orders of Government. At Coimbatore, there were three boys in the school with wages and twenty-four boys without wages as against five and fourteen during last year.

BOMBAY. The two vernacular schools at Devi-Hosur and Dhulia continued to work satisfactorily during the year. The Devi-Hosur school completed its 23rd year and has now got 301 passed students to its credit. These passed students have formed an association which meets from time to time and which has organised a co-operative credit society and a sales union among its members, many of whom take active part in propaganda work towards improved agriculture in their villages. At Dhulia thirty students attended the school, fifteen in the first year and an equal number in the second year. Horticultural and poultry keeping sections have been developed and the local Agricultural School Committee continued to manage the finances of the Institute efficiently. The Vernacular Agricultural School established at Rajpur in 1929 is doing very useful work and is gaining in popularity each year.

BENGAL. In the Secondary Agricultural School at Dacca in January, 1937, twenty students from over 500 applicants were granted admission in the first year class, Government giving seven stipends. Nine stipends were available from the District Boards. Eighteen students sat for the final examination in December, 1936 and fourteen passed. More District Boards are taking interest in this type of education by granting stipends to students from their districts.

PUNJAB. Sixty-six students attended the two six-monthly courses of the vernacular class at the Agricultural College and sixty passed the final examination. The demand for this education continues. The duration of the class has been extended to twelve months. Hitherto no tuition fees were charged

from students of this class but a small fee of Re. 1 per mensem per student has been levied very recently.

BURMA. The American Baptist Mission Agricultural School at Pyinmana received as usual a grant of Rs. 10,000 from the Agricultural Department budget. The school enrols each year thirty to forty students to whom it gives a two-year or a four-year course. In the present year eighteen students completed the course and passed the terminal test. In agricultural training by the department itself, the main work undertaken is the giving of 9 months course at each of the two farm schools at Hmawbi and Mahlaing. Ten to twelve entrants can be accepted at each farm school. For both schools the applicants for admission are now far in excess of the number which can be entertained. In all the circles the need for establishing these farm schools is now increasingly showing itself.

CENTRAL PROVINCES AND BERAR. The session of the Robertson Anglo-Vernacular Agricultural Middle School, Powarkheda, started with fifty-six boys on the rolls. Thirty-six boys were enrolled later which brought the total to ninety-two. Of the total number, half were the sons of *malguzars* and the remainder were the sons of cultivators. Seventeen boys appeared for the High School Entrance examination and twelve passed. The carpentry class opened last year showed satisfactory progress. The management of the Betul Bazar Anglo-Vernacular Agricultural Middle School was transferred from the District Council to the Agricultural Department. The Peace Memorial Agricultural School was opened at Buldana to give a two years' course of practical training to the sons of agriculturists of the district. The right type of students have not yet been attracted to the school. During the year, eighty-three applications for admission were received and twenty have been selected. Nine boys appeared for the final examination and eight were successful.

MYSORE. The total strength of the Hebbal Agricultural School was seventy of whom twenty-four were in the first year class, twenty-one in the second year class and twenty-five in

the Diploma class. The total strength at the end of the year was seventy-four. Thirty-one scholarships were granted. Out of thirty-four students that appeared for the Diploma examination twenty were successful. There has been a fall in the number of students seeking admission to the school. The Vernacular Agricultural Schools at Chikkanahalli and Ramakrishnapur continued to work satisfactorily.

TRAVANCORE. A batch of eighteen pupils was pursuing studies in the Agricultural School, Kottarakara in the beginning of the year under report. They made satisfactory progress with their studies and all of them passed the first annual examination. Twenty-four pupils admitted in the Agricultural School at Koni were continuing their studies at the beginning of the year. Fifteen passed the examination. A fresh batch of thirty-one pupils was admitted during the year. The number on the rolls at the close of the year was thirty and these boys were making good progress in their studies.

COCHIN. The agricultural school attached to the Central Farm had to be temporarily closed, as the Education Department could not depute a sufficient number of teachers for undergoing training in agriculture. Private students who sought admission also claimed some sort of help from the Government by way of stipends. The horticultural schools continued to make satisfactory progress and have become very popular. The final examination of the senior class was held towards the close of the year and out of fifty candidates examined forty-eight passed. More than fifty per cent of the boys after leaving the school took to agriculture.

4. Rural 'Bias' Schools

AGRICULTURAL classes in middle and rural schools continued to be popular. In MADRAS, lectures in elementary agriculture were delivered at the Y.M.C.A. Summer School of Rural Service held at Sulur in Coimbatore district for five weeks in April and May, 1936.

BOMBAY. The number of agricultural bias schools remained unchanged at ninety-three. The largest number in any district was thirteen in Belgaum. No further extension of these schools was possible for want of trained teachers. Rural clubs have been started in connection with most of the agricultural bias classes and perform a useful function in establishing contact with the past students and maintaining their interest in improved agriculture.

BENGAL. Fifty-seven schools including the Ushagram Boys' High English School in Burdwan and the King Edward Middle English School in Nadia conducted agricultural classes. Under the scheme adopted by Government, it is intended that the education given to boys in these schools should have an agricultural bias and should better equip them for practical farming. The number of students attending the agricultural classes in fifty-four schools rose to 3,845 and the progress made in thirteen of these schools is reported to be highly satisfactory. In these fifty-four schools the total area cultivated was 162 acres. About a dozen schools have shown a profit. In fifty per cent of the schools considerable improvement was noticed both in class teaching and field work. The scheme on the whole has not been working so satisfactorily in the High English Schools as in the Middle English Schools. In the King Edward Middle English School, the Government syllabus in agriculture is followed and the continuation classes are retained with some modifications. In the primary schools at Kishorganj and Burirhat Farms, two extra classes have been opened and are in full attendance as in the previous year. The grants to the Viswa-Bharati University were continued.

BIHAR. At the Darbhanga Raj School and at the Mahilla Vidyapith, Majhaulia, instruction in agriculture was given from time to time. Groundnut and sugarcane demonstrations were conducted in the English Middle School at Jitado. At the Pakur Raj English School, the Overseer delivered lectures on agriculture twice a month. A few demonstrations with sugarcane and other crops were conducted in some of the

schools supervised by the Sub-Inspector of Schools, Sheikhpura. Fifteen rural schools were visited by the Overseer, Kishunganj and improved methods and practices were explained to teachers and students of the primary and middle English schools. The students of the Wheeler English Middle School, Kanke, regularly attended the Farm on Saturdays and Sundays for training in agriculture.

CENTRAL PROVINCES AND BERAR. Agriculture was introduced into the curriculum of the Betul Government High School as an optional subject and the department set apart a portion of the Betul Station garden for use in practical training. In this district the chain of agricultural education from the middle school right up to the college is now complete. Departmental instruction in agriculture was continued at the vernacular middle schools at Amarwara, Lakhnadon and Chhapara and at the close of the year the students were examined by the Extra Assistant Director of Agriculture, Chhindwara. A special course in agriculture was given at the vernacular middle schools at Itki and Chandur where trained teachers were provided by the Education Department. Small plots were attached to the schools for practical training.

ASSAM. In most of the rural lower primary, English or vernacular middle schools, school gardening was started and is encouraged by the department. One hundred and seventy-four schools took to gardening during the year. The Polash Girls' School in Sunamganj has been a pioneer among girls' educational institutions in the Surma Valley to take to gardening. Agricultural produce sent from the school was highly appreciated in the Habiganj Agricultural and Industrial Exhibition. A silver medal was awarded to the School. Altogether fifty-eight students in the Lower Assam Valley, and twenty-two in the Upper Assam Valley took up gardening under the direction of the district staff.

HYDERABAD. The two night schools at Patancheru and Teegalnagram villages continued to function. Twenty-five villagers were taught during the year under report.

TRAVANCORE. The rural school at Ollannoor (the result of private enterprise) continued to make steady progress. The Agricultural and the Educational Departments rendered it all possible help during the year. A few more schools were started in other centres. Elementary agriculture forms a part of the curriculum of education at the vernacular schools. 5,719 candidates sat for the final examination during the year under report.

5. Short Courses

THESE courses which may last from a few days to a few months are being held in all agricultural institutions and are becoming very popular.

MADRAS. A number of courses in subjects such as farm management, care of animals, dairy training, malt-making, insect pests and diseases, jaggery-making, bee-keeping and horticulture, were given during the year in the Agricultural College at Coimbatore. Students attending the farm management course were permitted to attend other classes also. With a view to make the short courses popular it was thought desirable to confine them, as far as possible, to linguistic areas. Under orders of Government a ten months' course was started at the Agricultural Stations, Nandyal and Taliparamba during 1936-37. A course of practical training to be given to 150 students in several agricultural stations in the presidency was also started in agriculture for a period of four months. During the period under training, students were given a stipend of Rs. 15 a month.

BOMBAY. Special courses were as usual held at the College at Poona. The number of students attending being twenty-four as compared to fifteen of the previous year, indicating that the demand for such specialized practical training is increasing. A training class for oil engine mechanics was conducted by the Agricultural Engineer to Government. Twenty-four applications for admission were received of which thirteen students were admitted and received special training in oil engine management and care. Twelve students attended the

practical training classes in horticulture at the Ganeshkhind Fruit Experimental Station, Kirkee. In addition, district classes in horticulture were organised by the Horticulturist to Government at Satara, Godak, Palghar, Malsiras and Dahigaon and were attended by over 500 pupils.

BENGAL. In all, thirty-two boys were trained in seven batches of *bhadralok* youths in Faridpur out of which twenty-three were provided each with twenty *bighas* (40 yds. × 40 yds.) of land and a loan of Rs. 200 for starting agriculture. The scheme has been kept in abeyance since the 1st July, 1936 to see whether the majority of the men already trained can set themselves up as cultivators. Several young men of the *bhadralok* class were given training in mechanical work, the maintenance of agricultural machinery, and in the manufacture of *gur* and sugar by the departmental open pan method. It has been possible to find employment for some of them.

PUNJAB. In addition to courses already given, a few more courses were added during this year. These included the *lohar* (blacksmith) class, fruit culture and fruit preservation, a subsidiary industries course, a post-graduate course in sugar chemistry, a six months vernacular course in dairying, two courses in bee-keeping, two courses in estate management and a twelve months' course for *malis* (gardeners). There was a keen demand for admission to all these courses and practically all of them have been run at the maximum strength which the teaching facilities allowed.

BURMA. Most of the circles organized opportunities for cultivators to come in for training over various periods. In the Tenasserim Circle seventeen students attended a two-monthly course in general agriculture and horticulture and in Arakan seven cultivators attended the Akyab Farm for a period varying from six days to six months. In the East Central Circle a 4½ months' course was attended by nine cultivators. In the West Central Circle seven cultivators were given a four days' course in tobacco-curing. Lectures were given at township conferences of headmen in both the Arakan and the

West Central Circles. In the West Central Circle the practice of taking organised parties of cultivators from backward tracts to adjacent areas in which are established the crops and methods advocated by the department was continued. On all central farms vists of conducted parties from colleges and high schools are becoming customary. At all meetings and visits opportunities are taken to discuss and demonstrate improved crop and cultivation methods.

BIHAR. The Central Farms continued to train the overseers and *kamdars* in practical agriculture. During the year under report seventeen private persons were trained in practical agriculture at the Sabour Farm and one at the Banka Farm. Seven of these were absorbed as temporary *kamdars* and one is looking after his own private farm. Twenty-four students were trained in fruit preservation and canning at the Patna Farm. Twenty-nine overseers of the department in two batches were deputed to the Botanical Section at Sabour for training in the modern methods of lay-out of field trials and the interpretation of results thereof for a period of fifteen days. Five private persons have undergone training in practical agriculture at the Kanke Farm during the year.

CENTRAL PROVINCES AND BERAR. The Vernacular Dairy Course, which is, as usual, held in alternate years at the College at Nagpur, was due to be held during the year under report, but as there were only seven students of whom only one wanted to join the course it was held in abeyance.

ASSAM. Training classes at Sylhet and Jorhat Farms have released the first batch of students. About fifty *bighas* of Government waste land in one block have been acquired at Kokilamukh for the training of students of the Jorhat Training Class. This year, two new batches of students have been admitted at Sylhet and Jorhat. The classes have proved very popular. A large number of applications for admission was received in each place.

SIND. A scheme approved by Government for the training of zamindars and *haris* (tenants) in practical agriculture at

the Government Auxiliary Farms has been in force since last year. The essence of the scheme is that students under training should manage a holding of thirty-two acres under the direction and guidance of the Farm Manager and his staff. Moreover, the student is encouraged to improve cultivation and is given a share of the profits of cultivation on the *batai* (division of the crop between the cultivator and the zamindar) system. Arrangements have been made for the training of a good number of students at the Oderolai Farm on the Left Bank and at the Dadu Farm on the Right Bank. Six *hari* students were under training on the Government Auxiliary Farm, Dadu, out of whom four completed their course.

NORTH-WEST FRONTIER PROVINCE. A training class was started at the Tarnab Farm for candidates for the posts of *kamdars*. There were eight students in all, four of whom were from agencies.

HYDERABAD. At Patancheru, the Rural Development Centre is now serving as an institution for training rural development workers for the Dominions. This year, a training in all the aspects of rural improvement was given to thirty-five teachers of the village primary schools. The workers trained here are doing development work in their villages. The class for oil engine drivers was continued under the supervision of the Machinery Superintendent of the Farm. Two classes each of which was of three months duration were held during the year. Nineteen students attended the class this year of which fourteen passed successfully. This class has turned out 146 engine and pump drivers since its inception. The two-year gardeners' class was continued under the supervision of the horticulturist. Practical training is given in all operations connected with growing of fruits, vegetables and flowers. There were nine students on the rolls this year. In the two-year farmers' classes at Himayatsagar and Parbhani out of twenty-three and eighteen students on the rolls respectively, eleven passed from the former while ten from the latter.

BARODA. A new line of development is represented in the opening of a *mali* class under the horticulturist. The response

has been considerable. This opening class consisted of six *malis* and it is to be a course of one year. The horticulturist and his staff were in part engaged in the teaching of the class. At the institute it is intended that the number of short courses associated with agriculture ranging from two weeks to three months and covering such items as intensive modern agriculture, poultry, fruit-growing, fruit-canning, oil engines and dairying will be made available to the public. The first of these and the second last are now in progress.

Special three months agricultural classes covering the principal lines of the intensive propaganda were also held at Jagudan and Amreli.

COCHIN. Short courses of training in agricultural and horticultural methods were given at the Central Farm.

INDORE. During the year under report eighty persons from seventeen contributing States received practical training at the Farm in various subjects. These included agricultural officers and farm menials from the States, cultivators and students. In addition to those who actually came for training, a considerable number of cultivators and others interested in rural development visited the Farm to look round and to get an idea of what was going forward. Special courses of instruction are run at the Institute for the training of nominees of the States in particular subjects such as tobacco-curing, silage-making, statistics as applied to agricultural experimental work, etc.

IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI. A special course in the flue-curing of tobacco lasting for two months was organised at Pusa during the winter of 1937. It was attended by one candidate each from Madras, the Punjab, the United Provinces, and the Indore State.

The Overseer in charge of the Cattle Farm, Bharari (United Provinces), who was accompanied by a fieldman and ten herdsmen, a naik and a rifleman of the 9th Gurkha Rifles and a veterinary assistant from the Punjab received training in the methods of cattle management adopted at the Institute.

CHAPTER XIV

THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE*

SEVEN years of economic depression had put the co-operative movement to a severe test, but in 1936-37, the movement succeeded, even though partially, in resisting further disintegrating influences. On the whole, progress in the recovery of overdues was well maintained; in fact, in some provinces the percentage of overdues showed an improvement on previous year's figure. Except in Bihar, the credit of the central financing agencies also stood high, the borrowing rates in some cases being almost on the same level as those of well-established Joint Stock Banks. Those who were responsible for guiding this movement concentrated more on consolidating the position already gained and rectifying the defects which years of depression had thrown up to the surface, rather than on any wide expansion. Every province devoted attention to examining the nature and duration of overdues and classifying them into good, bad or doubtful debts according to the security which debtors could produce or their repaying capacities. In an effort to lighten the burden of these debts and adjust them to the existing low level of prices, various measures were adopted, *viz.*, permanent reduction in the rate of interest, exemption from the levy of penal interest, partial remission of interest subject to certain minimum payment by debtors, grant of adequate instalments, and writing off of irrecoverable debts against reserve fund, etc. Simultaneously, a cautious policy was adopted of advancing money mainly for productive purposes and on short-term loans. It was recognised that Agricultural Credit Societies should restrict their activities to providing short-term and intermediate loans leaving the provision

* The assistance of Mr. M. D. Bhansali, M.A., LL.B., Bar.-at-Law, I.C.S., J.P., Registrar, Co-operative Societies, Bombay Presidency, in the preparation of this Chapter is gratefully acknowledged.

of long-term capital to Land Mortgage Banks. Mainly on these grounds, the Registrars' Conference held during the year recommended that further development of Land Mortgage Banks should be encouraged. It was, of course, realised that so far as the Agricultural Credit Societies were concerned, fresh finance could not be restricted entirely to short-term loans, but in all cases the needs of the members and their repaying capacities were subjected to a very careful scrutiny. In every province and State emphasis was laid on the necessity of recovering loans punctually as they fell due. Another notable feature of the year under report was the particular interest taken in the co-operative movement by the Agricultural Credit Department of the Reserve Bank of India, whose publications on this subject provoked considerable thought and discussion on the various aspects of the working of Co-operative Credit Societies.

2. Co-operative Non-Credit Societies also received a good deal of attention. Years of economic depression had served to show that cheap credit provided by rural co-operative banks was not a panacea for all the difficulties of the cultivators. It was realised that unless all activities bearing on rural welfare could be organised on a co-operative basis, there was no reasonable likelihood of improving conditions of rural life. Efforts were therefore directed to organising, on a co-operative basis, activities relating to consolidation of holdings, improvement of live-stock, introduction of improved methods of cultivation, promotion of cottage industries, supply of agricultural and domestic requisites and processing and sale of farm produce, etc. Wherever possible all these activities were co-ordinated with the business of the credit societies. Notable instances of non-credit societies are furnished by the fencing and crop protection societies in Bombay, consolidation of holdings, better living and better farming societies in the Punjab, loan and sale societies in Madras and village welfare societies in Bihar.

3. The enormous strain to which the co-operative staff was subjected on account of conditions of persistent depression had

already created a strong demand for additional staff. The necessity for promotion and extension of non-credit activities on a wider scale made this demand almost irresistible. Wherever adequate and well-trained staff was available to guide, supervise and control the movement, not only was the pace of recovery accelerated but substantial advance was achieved. The movement in the Punjab provided a good illustration of what could be achieved by the employment of well-trained adequate staff. In his inaugural address at the Twelfth Conference of Registrars, the Honourable Sir Jagdish Prasad pertinently observed that " Governments . . . . . have not been able to devote as much money to this movement as it required or as circumstances would have demanded " and that " except in the Punjab where the net expenditure as compared to the revenue is just a little over one per cent., in most of the provinces it is below ½ per cent." With the general improvement in the finances of the provinces and the increased attention that is being paid, of late, to rural conditions in India, it is expected the co-operative movement will receive greater attention than before from all persons interested in the welfare of rural India.

4. The Royal Commission on Agriculture laid great emphasis on " the patient and persistent education in the principles and meaning of co-operation of the members of primary societies by teachers competent to perform the task." The allotment of Rs. 15 lakhs made by the Government of India enabled the provinces to organize arrangements for the training of the staff and members and office-bearers of primary societies. It is hoped that with this countrywide campaign for education in the principles and methods of co-operation, the movement itself will be placed on a surer foundation.

5. Some detailed figures regarding the movement in the different provinces and States are furnished below :—

PUNJAB. The year witnessed a real improvement and extension in the work of co-operative societies. The number of agricultural credit societies increased from 16,820 to 16,982 and their membership from 506,169 to 514,152. The recoveries

were satisfactory and amounted to Rs. 105·48 lakhs towards principal as against Rs. 97·71 lakhs last year. The percentage of recoveries of principal to the amount outstanding at the beginning of the year—this might be regarded as an index of, and a test for, the healthy functioning of societies—increased from 13·6 to 16·03. In view of the substantial recoveries during the year, the total amount on loan to members dropped from Rs. 658·05 lakhs to Rs. 630·19 lakhs. The figure of overdue interest also showed a reduction of Rs. 4·41 lakhs at the close of the year. The amount of fresh loans advanced during the year was Rs. 96·82 lakhs as against Rs. 96·65 lakhs last year. Of this, a sum of Rs. 7·82 lakhs was loaned for meeting ceremonial expenses. In this connection, the Registrar observed that " The increase in loans for ceremonies is regrettable in so far as it shows that the lesson of the depression has not been fully learnt ". Definite attempts were made to confine the loans as far as possible to short-term purposes. Of the total amount loaned during the year, only Rs. 379 lakhs were at a rate exceeding $9\frac{3}{8}$ per cent per annum. The general reduction in the rate of interest proved a source of great relief to members. The deposits of members in the societies also recorded an increase of Rs. 1·82 lakhs.

2. The twelve land mortgage banks in the province recovered during the year Rs. 2·09 lakhs as against 1·76 lakhs in the previous year. The amount of fresh loans issued by the Banks during the year was practically insignificant. The overdues in the Banks increased from Rs. 3·92 lakhs to Rs. 4·79 lakhs. The question of reorganization of these Banks was receiving serious attention of the authorities.

3. The activity in connection with consolidation of holdings was carried on with increased vigour and enthusiasm. Four years ago the area consolidated during the year was 56,148 acres. During the year 1936-37, the area consolidated reached a record figure of 120,295 acres. The total area consolidated in the province up to 31st July 1937 was 791,358 acres. The amount of contributions collected from members during the

year was Rs. 51,000 as against Rs. 45,000 in the previous year. The rate of contributions was about As. 9 per acre in most areas. The Government of the Punjab maintained a staff of eight Inspectors and 104 Sub-Inspectors for this purpose. To these were added seven Inspectors and eighty-three Sub-Inspectors, employed out of the Government of India grant for rural reconstruction. In addition to these, eight Assistant Inspectors and thirty-seven Sub-Inspectors were maintained out of contributions collected from villages under consolidation. The difficulty of obtaining trained staff and the necessity of ensuring adequate and efficient supervision prevented the department from increasing the pace of consolidation still further.

4. The Better Farming Societies demonstrated their usefulness as agencies for spreading better farming by their varied activities. The total quantity of seed distributed through these societies increased from 1,499 maunds to 3,518 maunds. In addition to the distribution of seed, a large number of improved agricultural implements of various kinds was supplied by these societies.

5. Another line of advance was the promotion of societies for improvement of live-stock. Cattle-breeding societies increased from 191 to 222 and Sheep-breeding societies from 7 to 12.

6. Better Living Societies continued to multiply and extend their activities. The number of these societies increased during the year from 736 to 920. Among the achievements of these societies might be included restriction of expenses on ceremonies, fixation of marriageable age for youths, prohibition of beggars, settlement of village disputes, fixed payments to doctors for regular visits to village patients, promotion of sanitation and personal hygiene, establishment of village libraries, etc.

7. The campaign for the general education of members, particularly secretaries and office-holders of societies, continued with vigour. Eighty-eight classes for Secretaries and 102 classes for office-bearers of societies were held during the year, the attendance being 1,247 and 4,372 respectively. Two classes

for women were also organized during the year, the attendance being 188.

BOMBAY. The agricultural season was highly unfavourable over a large part of the province. Famine and scarcity conditions prevailed in parts of Gujarat, Deccan and Karnatak, and shortage of fodder increased the rate of mortality among cattle. Despite these adverse conditions, the movement maintained steady progress. The number of agricultural credit societies increased from 3,614 to 3,718. Their membership, however, fell from 199,522 to 198,203, the principal reasons for the decrease being the winding up of some societies with large membership and the policy of weeding out undesirable members. The fresh finance made available to members during the year was Rs. 78·48 lakhs as against Rs. 69·29 lakhs in the previous year. The recoveries from members amounted to Rs. 72·59 lakhs as against 71·13 lakhs in the previous year. The percentage of unauthorized arrears to demand was reduced from 60 to 52. The policy of consolidation and rectification combined with cautious expansion, which has been followed by the department for several years, has proved effective in arresting the pace of further deterioration. The main problem of the agricultural credit movement in the province is the growth of overdues and the consequent stagnation in the business of societies. Efforts were made during the year to examine the nature of overdues and to classify them according to the security or repaying capacity of debtors into good, bad and doubtful debts. Definite measures were also advocated for treating various classes of debts with a view to progressively reduce the burden on the debtors to the level of existing prices. The number of societies which availed of the concession scheme was 874 and the remissions of interest earned by their members were Rs. 205,483. Permanent reductions in the rates of interest were also allowed in all cases where the financial position and the character of management of societies justified such relief.

2. The Provincial Land Mortgage Bank continued to maintain its progress. The loans advanced by the Bank up to the

close of the year were Rs. 6,30,575, of which Rs. 27,819 were due for repayment during the year. The whole of that amount was recovered from Primary Banks. Government have agreed to guarantee principal and interest of the first series of debentures of the Bank for Rs. 20 lakhs. Pending, however, the approval of Government for the Debenture Trust Deed, the Bank could not float its debentures during the year.

3. The number of Primary Land Mortgage Banks was stationary. The three old Banks registered in the year 1928-29 accepted new Bye-laws and affiliated themselves to the Provincial Land Mortgage Bank. The amount of loans disbursed by these Banks rose to Rs. 6,65,072, of which Rs. 36,614 were due for repayment during the year. Out of the amount due, Rs. 17,615 towards principal and Rs. 14,546 towards interest were recovered during the year. The recoveries in the old Banks are not so satisfactory. The bulk of the loans had, as their object, the redemption of old debts. The Debt Conciliation Committees set up by these Banks secured remissions to the extent of Rs. 1,14,668 from *sawkars* (money-lenders). The Committees, however, are reported to have been considerably handicapped in their work, as they have no statutory authority to call for statements of accounts with regard to debts which are to be compromised.

4. The Registrar observes that " Past experience has demonstrated that credit, if it is not buttressed by thrift, better living or marketing, does not make any headway." Accordingly, the encouragement and development of non-credit activities formed the main planks in the policy pursued by the department. The Cotton Sale Societies, which numbered twenty-eight, sold 655,558 maunds of cotton or lint as against 365,000 maunds last year, the price realized being Rs. 44,80,279 as against Rs. 33,00,000 in the previous year. The progress in the direction of co-operative processing was also maintained. The Purshottam Ginning Society ginned 93,313 maunds of cotton and saved its members hundreds of rupees in ginning and pressing operations.

5. The number of Fencing Societies was fifteen with a membership of 1,522. The length of the fence increased from 68,000 yards to 80,794 yards and the area protected from 20,000 acres to 27,343 acres. Most of these societies in Dharwar division are now affiliated to a Union which guides and co-ordinates their activities. The number of Co-operative Crop Protection Societies, which organise hunting parties and guard crops against wild animals, incendiarism, theft, etc., was twenty at the close of the year. The area protected by these societies was 94,771 acres as against 53,000 acres in the previous year.

6. The number of Taluk Development Associations which promote better farming by arranging for the supply of pure seed, fertilizers and implements, introduction of improved methods of cultivation, improvement of live-stock, etc., increased from ninety-five to 103. The contributions collected from members amounted to Rs. 35,000 as against Rs. 33,498 last year. Government and the District Local Boards granted subsidies to these associations to the extent of Rs. 48,520 and Rs. 21,637 respectively during the year.

MADRAS. In spite of the persistence of economic depression, there was a distinct improvement in the financial position of the agricultural societies. Their number at the close of the year was 11,110 as against 11,029 in the previous year, excluding the societies in the Ganjam district, which was transferred to the new Province of Orissa. Of these, 10,502 were credit societies and ninety-three land mortgage banks. The societies advanced during the year loans to members to the extent of Rs. 162·90 lakhs as against Rs. 148·22 lakhs last year. With the advent of the depression, there was an appreciable contraction in the loan transactions of societies and this had seriously detracted from the usefulness of societies. The progressive increase in the volume of fresh loans is an index to the gradual recovery of the movement from the effects of the depression. The bulk of the fresh loans was issued for productive purposes and for short periods. The Registrar advised the Central Banks and ordinary credit societies to desist from the issue of loans for

redemption of prior debts and to leave it to the Land Mortgage Banks. The efficacy of the policy of rectification pursued by the department was reflected in the growing volume of recoveries. In central banks, the percentage of arrears under principal came down from 57·87 to 51·15. In agricultural societies, the percentage of arrears fell from 65·35 to 58·76. During the year, many of the societies deleted from their bye-laws provisions for the levy of penal interest. The benefit resulting from this measure to the members was estimated at Rs. 2·84 lakhs. Many of the societies also reduced their lending rate to 7½ per cent per annum with retrospective effect. The savings to members on the score of such reduction were estimated at Rs. 3·49 lakhs. The question of granting adequate relief to debtors was under the serious consideration of the authorities.

2. The Central Land Mortgage Bank continued to progress on sound lines. The money market continued to be easy throughout the year and the Bank was able to float debentures at low rates varying from 3½ to 3 per cent. The debentures of the Bank were quoted at a premium in the market and enjoyed the confidence of the investing public. During the year the Government increased the maximum of their guarantee in respect of debentures from Rs. 100 lakhs to Rs. 125 lakhs. The overdues were conspicuous by their absence in the Bank.

3. The number of primary land mortgage banks increased from eighty to ninety-three. 9,739 villages were covered by the existing banks and loans were issued in 2,974 villages. The total amount of loans issued by these banks up to 30th June 1937 was Rs. 141·24 lakhs. The percentages of arrears under principal and interest were reduced from 20·64 and 4·33 to 14·15 and 3·85 respectively during the year. The remissions secured during the year from creditors by the banks amounted to Rs. 1·56 lakhs as against Rs. 0·55 lakh last year.

4. The number of loan and sale societies increased from 74 to 111. The societies advanced loans to members to the extent of Rs. 31·10 lakhs during the year. Government encouraged the construction of godowns by offering the societies free grant of

25 per cent of the estimated cost of such godowns. So far thirteen societies were given grants amounting to Rs. 34,150 out of the subsidy from the Government of India. Government also granted, during the year, to four societies loans to the extent of Rs. 12,000 for the construction of godowns. These societies, though they do not undertake pooling or joint sale of produce, constitute an essential stage in the development of co-operative marketing.

5. The Provincial Marketing Society, which was started last year to facilitate and co-ordinate the working of loan and also sale societies and stores, continued to show good progress. The society dealt with oranges, potatoes, plantains, mangoes, onions, garlic, eggs, honey, ghee, hand-pounded rice, tamarind and jaggery, the value of such goods sold being Rs. 8,979. It also disposed of sugar of an aggregate value of Rs. 1·75 lakhs. The Society issued a weekly bulletin showing the prices and attended to trade enquiries. Financial assistance from Government in the earlier stages and unflinching loyalty of the affiliated primaries are essential for the success of the society.

6. The scheme of controlled credit, which was being worked out in the province and which aimed at linking up the land mortgage bank, the rural credit society and the sale society received the approbation of the Registrars' Conference which recommended its examination and adoption by other provinces.

UNITED PROVINCES. Despite the persistence of depression, the financial position of agricultural credit societies, which numbered 6,427 at the close of the year, showed marked improvement. The recoveries in the societies increased by Rs. 2·09 lakhs to Rs. 30 lakhs. Advances to members also increased by Rs. 1·08 lakhs to Rs. 32·24 lakhs. The overdues, on the other hand, decreased by Rs. 1·86 lakhs to Rs. 36·21 lakhs. The percentage of recoveries to demand, which might be regarded as a correct index to the healthy functioning of societies, rose from 40·9 to 45 during the year. The working capital of societies also increased from Rs. 103 lakhs to Rs. 105·4 lakhs, of which Rs. 62·8 lakhs, *i.e.*, nearly 60 per cent constituted the

owned capital of societies. Of 6,427 societies, 1,844 distributed dividends, 1,252 gave rebate to members and 1,547 reduced their lending rates. The number of societies in arrears of interest was again reduced from 789 to 775, and the amount of overdue interest fell from Rs. 3·65 lakhs to Rs. 3·14 lakhs. With the reduction of debts to reasonable dimensions and their conversion into long-term loans on the one hand, and with separate provision of crop requirements and encouragement of repayments in kind on the other, it might be expected that a large number of societies would be gradually pulled out of the rut.

2. The number of land mortgage societies remained unchanged at five. The recoveries in these societies increased from Rs. 7,271 to Rs. 8,490. Advances, however, dropped from Rs. 42,980 to Rs. 27,420. Overdues amounted to Rs. 1,167, of which Rs. 400 were realized after the close of the year.

3. The Registrar observes that " It is now generally recognized that credit, however necessary, cannot by itself go a very long way " and that " the aim should be to embrace the whole man in the member so as to make him a more efficient producer of the country's wealth ". Accordingly, greater attention was directed to the promotion and extension of non-credit activities. The number of cane-supply societies, which occupy an important place in the rural economy of the province, increased from 322 to 514. The quantity of cane sold by these societies was 127 lakhs of maunds as against 75 lakhs of maunds in the previous year. The Cane Development Scheme which was recently introduced continued to make steady progress. The number of " Ghee " societies rose from eighty to 153. These societies had a membership of 3,153. During the year the societies handled ghee worth close upon a lakh and made a profit of Rs. 18,476. The Provincial Marketing Board proposes to set up a grading and testing station at Shikohabad. This would enable the certified produce to commend a ready market in Calcutta and other places. The number of consolidation of holdings societies increased from eighty-two to ninety-four. Nearly 39,000 plots have so far been consolidated into about 3,900 plots at a cost of

annas seven per *bigha*. The whole work was done by persuasion and the societies were registered after consolidation had been effected and possession had been actually transferred. The number of Irrigation Societies also rose from thirty-six to fifty-one. A rural insurance society was formed, its membership being confined to the clientele of credit societies. The minimum and maximum amounts for which a member can be insured are Rs. 25 and Rs. 250 respectively. Better farming and better living societies also increased in number and continued to do valuable work.

CENTRAL PROVINCES AND BERAR. For the first time since 1930, the agricultural season was favourable. Berar reaped a harvest, the like of which was not witnessed for many a year. Prices of cotton, the principal money crop in the province, ruled relatively high. There was, however, little noticeable improvement in the position of the co-operative movement, particularly because it had passed through a long period of continuous and unprecedented depression. The Registrar observes that " Although the financial position of the movement, taken as a whole, is quite sound, it cannot be said to be in a healthy state of existence except in the three district banks of the old Chhattisgarh Division and to a less extent in the Banks of Brahmapuri, Bhandara, Wardha, Harda, Khandwa and Narsinghpur. Elsewhere it has generally ceased to be a live agency of rural credit." The number of agricultural credit societies at the close of the year was 3,708, of which, 3,126 were in the Central Provinces and 582 in Berar. The cash recoveries from members of societies in Berar increased from Rs. 266,300 to Rs. 438,278. Though there was a welcome improvement in collections in Berar, the recoveries were not as good as might be for the reason that a substantial portion of the profits from agriculture went towards wiping out huge arrears of land revenue which had accumulated since 1930, the first year of the depression. The recoveries in the Central Provinces fell from Rs. 8,41,577 to Rs. 8,19,442. Cash advances to members increased from Rs. 6,72,433 to Rs. 7,53,173, the amounts loaned in the Central

Provinces and Berar being Rs. 6,26,265 and Rs. 1,26,908 respectively. The extension of Debt Conciliation Boards has tended to contract fresh finance, for loans given subsequent to debt conciliation cannot be recovered through coercive action until all instalments have been paid up. Amendment of the Debt Conciliation Act to remove this difficulty is under contemplation. The proportion of overdues was reduced to 69·9 per cent in the Central Provinces, while it rose to 92·2 per cent in Berar.

2. The number of Land Mortgage Banks increased from ten to twelve during the year. The number of new applications received by the Banks was 500, the amount of loan applied for being Rs. 6,01,570. The amount actually advanced during the year was Rs. 2,64,385 and the amount recovered was Rs. 17,727. The overdues amounted to Rs. 2,076, about 50 per cent of which was recovered after the close of the year. Pending the establishment of a Central Land Mortgage Bank, the Provincial Bank continued to perform its functions. The second series of debentures for Rs. 3,00,000 was floated at 3½ per cent on 1st October 1937, *i.e.*, after the close of the year. The Registrar points out that " taking Banks and Boards together it can be fairly said that the province has set up a record in relief of agricultural indebtedness, which it would be difficult to beat."

With the growing realization of the limitations of credit greater attention was naturally devoted to the promotion of non-credit activities. The number of agricultural societies for purposes other than credit rose by five to seventy-two. Of these, forty-five are agricultural associations, fifteen seed unions, and ten ' Adat ' shops. Agricultural associations worked under the general guidance of the officials of the Agricultural Department. Much of their business was confined to the supply of improved machinery and pure seed. The ' Adat ' shops did not do well for various reasons such as absence of godowns, lack of loyalty and integrity on the part of members, fluctuating prices of cotton and want of standardization in the quality of produce.

ORISSA. This province shares its Registrar with the Province of Madras. The agricultural season was on the whole satisfactory, though the economic depression persisted and the prices of commodities remained more or less on the same level. During the year attention was particularly focussed on the reconstruction and consolidation of existing societies. The number of agricultural societies at the close of the year was 485, of which 476 were credit societies and the rest Purchase and Sale Societies. The total demand in the societies amounted to Rs. 10·15 lakhs, of which Rs. 2·20 lakhs were collected during the year. The percentage of overdues to demand was reduced in the case of long-term loans from 81·54 in 1935-36 to 80·30 during the year and in the case of short-term loans from 83·68 to 79·37. The loans advanced by societies to their members amounted during the year to Rs. 1·25 lakhs, the corresponding figure for 1935-36 being Rs. 1·9 lakhs. The bulk of the loans were for productive purposes. About 27 per cent however, of the loans were issued for the discharge of prior debts. The Registrar pointed out that the issue of loans for the discharge of prior debts was not the legitimate function of agricultural credit societies.

2. Investigations for the organization of Land Mortgage Banks were carried out during the year and the formation of one such bank for the two taluks of Berhampore and Chatrapore was recommended. The question of enacting a legislative measure for the regulation of Land Mortgage Banks was also under the consideration of the Orissa Government.

3. Purchase and Sale Societies had a membership of 5,428 and a paid-up share capital of Rs. 27,919. The value of goods sold to members amounted to Rs. 30,571, while the value of the members' produce purchased by the societies was Rs. 27,876.

BIHAR. The agricultural season was unfavourable. Some areas suffered from floods and untimely rains while others had to face droughts. Prices of agricultural produce showed no appreciable improvement during the year. In these adverse circumstances the stagnation in the agricultural credit societies

was aggravated. The recoveries were poor, being only 6·6 per cent of the demand on account of principal and 13·1 per cent of the demand on account of interest. There was during the year a further contraction in fresh finance issued to members, which dropped from Rs. 3·98 lakhs to Rs. 3·56 lakhs. The repayments of loans by societies to Central Banks also recorded a steady decline. In thirty-one Banks the collection was below 5 per cent while in fifteen Banks it varied between 5 and 10 per cent. Only two Banks showed collection of more than 40 per cent. The total amount of loans advanced by Banks to societies fell from Rs. 4·46 lakhs to Rs. 3·89 lakhs. The Registrar observes that " at present many of the Banks are meeting their cost of management from borrowed capital which is disquieting " and that " a comprehensive scheme of financial rehabilitation has to be enforced with the least possible delay for saving the movement from utter destruction ". During the year the department issued, with the approval of Government, three financial circulars which laid down a policy of relief as well as consolidation.

2. A redeeming feature is the greater attention which is being devoted to the development of non-credit activities. The organization of special types of societies such as village welfare societies, better living societies and sugarcane growers' societies was encouraged by the department during the year. Under the scheme sanctioned by Government in February 1936, several societies for the marketing of sugarcane on a co-operative basis were formed. Two special officers were placed in charge of this work and the cost of the scheme was met out of the Sugar Excise Duty collected by the Government of India. The increasing demand for the organization of these societies, which are becoming popular, is a hopeful sign for the future of the movement in the province.

3. Another feature of the year's work, which is expected to help the revivification of the movement is the establishment of the Training Institute at Pusa. The comprehensive training in all branches of co-operation which is being provided for the

officers of the department, the Bank staff and the office-bearers and members of societies under the scheme subsidized by the Government of India cannot fail to strengthen and stabilize the movement. The two Educational Inspectors and seventeen Instructors employed under the scheme have been deputed, after six months' training at the Institute for field work.

NORTH-WEST FRONTIER PROVINCE. The number of agricultural credit societies increased from 549 to 607 and their membership from 13,690 to 15,018. Great caution was exercised in the registration of new societies and care was taken to see that the prospective members had imbibed the virtues of thrift and mutual help. The recoveries which were Rs. 1·75 lakhs against principal and Rs. 0·86 lakh against interest maintained last year's level, despite the fall in the price of *gur* and the disturbed conditions due to Waziristan unrest. Fresh finance to members, which amounted to Rs. 2·54 lakhs as against 2·71 lakhs last year, was confined largely to productive purposes.

2. The number of non-credit societies rose during the year from twenty to twenty-five. Five new societies for consolidation of holdings were registered during the year. The area consolidated by the societies was 6,618 acres as against 5,186 acres in the previous year.

3. The grape sale society had a more prosperous year. The society sold during the year grapes amounting to 150 maunds as against 108 maunds last year. The Agricultural Marketing Office of the Government of India assisted the society by a grant for meeting the expenses on account of the salaries of a packer, grader, clerk and peon.

4. The Taru Jabba Egg Grading and Sale Association, though registered shortly after the close of the year, formally started work on 1st January 1937. During the period of six months, 18,79,518 graded eggs were collected and sold, the price realized being Rs. 76,291. The Association received substantial help from the Agricultural Marketing Office of the Government of India. It also succeeded in obtaining a concession in railway freight for graded eggs.

5. Seventeen classes for the Secretaries and twenty-eight classes for office-bearers of societies were held during the year, the attendance at the classes being 336 and 613 respectively.

ASSAM. The movement passed through another year of crisis. Though there was slight improvement in the price level of agricultural commmodities in some parts, the general position of agricuturists, who were hit hard by the depression, showed no material improvement. The policy of consolidation and cautious expansion was continued during the year. The number of agricultural societies dropped from 1,301 to 1,296, of which 1,263 were credit societies. The recoveries in this class of societies during the year amounted to Rs. 1,67,286 as against Rs. 1,55,467 in the previous year. The loans issued to members during the year amounted to Rs. 66,610 as against Rs. 59,771 in the previous year. The overdues were heavy and amounted to 94 per cent of the demand, which stood at Rs. 18,85,929. Loans repaid by societies to Central Banks were Rs. 95,601 as against Rs. 69,896 in the previous year. The loans issued to societies by Central Banks declined during the year from Rs. 40,498 to Rs. 39,751. The growth of heavy overdue in the existing societies rendered them an unsafe field for fresh finance from Central Banks. The only way to avoid increasing contraction of business was to organize new societies and rejuvenate old ones. The Registrar observes :—

> " With adequate staff at my disposal, it is not yet too late to bring in a turn in the movement. Reorganization and re-shuffling of the entire agriculture credit are absolutely necessary to save the movement from wreckage in the long run."

2. The number of land mortgage banks was stationary. The overdues in these Banks exceeded 98 per cent. and the position continued to be disquieting. The unsound policy of issuing long-term loans with short-term deposits was mainly responsible for the deadlock created in the business of these banks. Here also reorganization was a pressing need.

3. The redeeming feature is the organization of societies for development of cottage industries, such as hand-loom weaving. Two co-operative weaving inspectors were employed with the aid of the grant from the Government of India and each of them organized six new societies. Unless the slender income of the agriculturists is supplemented by earnings from subsidiary occupations, and their repaying capacity is raised, there can be no prospect of healthy development of the credit movement.

4. Another line of development which will help the revival of the movement is the provision of arrangements for co-operative education. The special allotment of Rs. 28,400 from the Government of India has enabled the department to launch a vigorous campaign for the general education of members in the principles of co-operation.

DELHI. On the whole, agricultural conditions were favourable. The price of sugarcane, however, had dropped below a remunerative level. The number of agricultural societies increased from 217 to 220. The number of agricultural credit societies, however, decreased from 203 to 200. The total recoveries were Rs. 1·42 lakhs as against 1·20 lakhs in the previous year. The fresh loans issued to members, however, fell from Rs. 43,384 to Rs. 42,568. In order that further expansion in credit activities might be undertaken, efforts were made to interest well-to-do and well-educated persons who had hitherto kept aloof, in the work of societies.

2. Among non-credit activities calculated to improve the economic condition of agriculturists, societies for consolidation of holdings had a place of pride in the province. Their number at the close of the year was eighteen. The area consolidated was 3,274 acres, the number of blocks having been reduced from 5,183 to 1,163. The average size of a block increased from 0·63 acre to 2·81 acres. The cost of consolidation varied between Re. 1-5-0 and Re. 1-6-0 per acre. As there was no spontaneous demand for this reform from the people, no contributions were recovered from them.

3. Another important line of advance was the cattle-breeding societies which numbered two at the close of the year. Rs. 41 were won by members of these societies as prizes by entering their animals for cattle-shows.

4. The special staff employed in the Punjab for the education and training of members also extended its activities to this province.

MYSORE. Attention continued to be concentrated on the rectification of dormant and moribund societies. The number of agricultural societies was reduced from 1,451 to 1,417. Of these, 1,337 were credit societies, twenty-two agricultural supply societies, thirty-six grain banks, and four marketing societies. Credit societies recovered Rs. 8,30,821 from their members as against Rs. 7,80,620 in the previous year. The percentage of overdues to demand dropped from 78·3 to 75·9. They issued fresh loans to members to the extent of Rs. 8,05,661 as against Rs. 7,30,796 last year.

2. The purchases and sales in supply societies amounted to Rs. 3,034 and Rs. 3,020 respectively. Some of these societies showed signs of improvement during the year. A few credit societies also understood the supply of agricultural requisites as an adjunct to their business.

3. Grain Banks and Marketing Societies did not function satisfactorily and stood in need of reorganization.

4. The Central Land Mortgage Bank collected Rs. 53,944 out of the total demand of Rs. 67,927 during the year. The percentage of overdues to demand dropped from 45·25 to 20·58. The improvement in collections was due to a slight rise in the prices of areca and the pressure put on the borrowers for prompt payment.

GWALIOR. The number of agricultural credit societies dropped from 4,183 to 4,028. The decrease was largely due to the policy of the department to wind up unhealthy and defunct societies. There was, however, an increase in the membership and working capital of these societies, which was due to the policy of judicious reorganization. Repayments from members

towards principal and interest amounted to Rs. 11,23,930 and Rs. 1,67,762 as against Rs. 12,08,327 and Rs. 2,78,819 respectively in the previous year. Fresh loans issued to members rose from Rs. 9,89,318 in 1935-36 to Rs. 12,93,327 in the year 1936-37. The bulk of loans was advanced for productive purposes.

2. The outstanding event of the year was the appointment of Prof. V. G. Kale, to hold an enquiry into the condition of Co-operative Institutions in the State.

TRAVANCORE. The policy of rectification and consolidation and of cautious advance was continued during the year. Forty-six societies were ordered to be wound up as against twenty-seven last year. The number of societies that deserved cancellation was larger, but the weapon of dissolution could not be applied in all cases owing to the difficulties of getting through liquidation work expeditiously. The number of agricultural societies fell from 1,380 to 1,346. Of these, 1,335 were credit societies. The recoveries in these societies against principal and interest amounted to Rs. 6,14,821 and Rs. 1,99,062 as against Rs. 5,21,651 and Rs. 1,91,202 respectively in the previous year. The percentage of arrears under loans was reduced from 79 to 76·8.

2. During the year greater attention was paid to development of non-credit activities. Existing credit societies were also prevailed upon to include in their programme, co-operative marketing of their members' produce and other similar activities.

BARODA. The number of agricultural societies increased from 893 to 900. Of these 756 were credit societies. The amount of loans collected from members during the year was Rs. 6,38,702 as against Rs. 6,99,505 in the previous year. The fall in the recoveries was due to an unfavourable season and scarcity of rain in some parts. The percentage of overdues increased from 45 to 46·7. Fresh loans advanced to members were Rs. 5,93,538 as against Rs. 6,06,131 last year. Some of the societies and banks in the State combined the work of supply

of agricultural requisites and sale of produce with that of provision of credit. The Kodinar Co-operative Banking Union sold 7,868 maunds of cotton received from seventeen societies for Rs. 25,551. It also supplied 2,967 maunds of cotton and wheat seed to thirty-eight societies during the year.

2. The Baroda Land Mortgage Bank advanced loans to the extent of Rs. 1,54,550 and recovered all instalments of Rs. 11,732, which fell due for repayment during the year. The repayments were punctual. The Government defrayed the full expenditure of the Land Valuation Officer and half the expenditure of the Bank amounting to Rs. 2,575. The Government also guaranteed the principal and interest of the debentures of Rs. 3,00,000 to be shortly issued by the Bank.

3. Out of eighteen Cotton Sale Societies in the State, fourteen functioned actively during the year. The quantity of cotton collected from 1,223 members for sale was 6,546 *bhars*, of which cotton weighing 6,525 *bhars* was ginned before it was sold.

JAMMU AND KASHMIR. The agricultural credit movement stands in need of consolidation rather than expansion. There were, in the State, at the close of the year, 2,576 agricultural credit societies with a membership of 46,823. The total amount on loan at the end of the year was Rs. 50,78,252 of which Rs. 8,37,033 were overdue. The principal recovered during the year amounted to Rs. 2,35,570, while fresh advances made to members amounted to Rs. 2,12,314. The recovery of principal worked out at 11·8 per cent of the outstandings at the beginning of the year. Fresh advances worked out at Rs. 4-8-0 per member.

2. Among non-credit activities, societies for consolidation of holdings are most important. Their number increased from 180 to 184. The number of Compulsory Education Societies increased from ninety to 104. These societies did some useful work. The number of better living societies also increased from ninety-six to 118. These societies could do much better work, if adequate staff were available.

CHAPTER XV

PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS

A COMPLETE list of the agricultural and animal husbandry publications issued in India during the year under review is given in Appendix XV. A brief summary of the publications of the Central, Provincial and State Departments of Agriculture is given below :—

Central Government Publications. The three Journals published by the Council, *viz.*, *Agriculture and Live-stock in India* (bi-monthly), *The Indian Journal of Agricultural Science* (bi-monthly), and *The Indian Journal of Veterinary Science and Animal Husbandry* (quarterly), entered their seventh year of life during the year under report.

The number of original articles published in *Agriculture and Live-stock in India* was thirty-eight, of which twenty-three related to crops and soils and fifteen to animal husbandry subjects. In addition, the journal contained seventy-five abstracts, forty-one notes and eleven reviews. The six numbers of the *Indian Journal of Agricultural Science* published during the year contained altogether seventy-seven original contributions, of which twenty-eight may be classed as botanical, eleven as entomological, nineteen as chemical, nine as statistical and ten dealing with plant diseases. In addition, there were three notes, four abstracts and five book-reviews. Of the twenty-three original contributions published in *The Indian Journal of Veterinary Science and Animal Husbandry*, sixteen dealt with animal diseases, four with animal nutrition and three with dairying. The arrangement started last year for publishing in this journal abstracts of articles selected from foreign literature which would be of interest to Indian field workers was continued and thirteen such abstracts were published during 1936-37.

Apart from the Journals mentioned above, the following publications were issued during the year:—

(*a*) Miscellaneous Bulletins—

No. 9. Statistical Methods and their Application to Agronomy. A Bibliography, by K. K. Guha Roy.

No. 10. Diseases of Sugarcane and Methods for their Control, by L. S. Subrahmaniam.

No. 11. Tables of Standard Errors of Mendelian Ratios, compiled by Swarn Singh Purewal and P. Krishna Rao.

No. 12. List of Publications on the Botany of Indian Crops, Part II, for the period 1928-32, by R. D. Bose.

No. 13. Two New Statistical Tables based upon Fisher's '*t*', by M. Vaidyanathan.

No. 14. List of Publications on Indian Entomology (1935), compiled by the Imperial Entomologist, Pusa.

(*b*) A Handbook of Statistics for use in Plant Breeding and Agricultural Problems, by Dr. F. J. F. Shaw.

Two Miscellaneous Bulletins and one Scientific Monograph were in the press at the end of the year.

Provincial and State Publications. The MADRAS Department of Agriculture issued two bulletins, two pamphlets, one note and sixteen leaflets in both English and the principal languages of the province. The Annual Villagers' Calendar was published in English and four provincial languages and 61,750 copies were distributed. A 'Popular Account' of the department's activities covering a period of thirteen years was in the press. *The Madras Agricultural Journal*, issued by the Madras Agricultural Students' Union, continued to be popular.

In BOMBAY, the Department issued two bulletins and several leaflets. *The Poona Agricultural College Magazine* was issued quarterly. The Deccan Agricultural Association published its

monthly Marathi magazine, the *Shetki and Shetkari*. The Kanarese and Gujarati agricultural journals were also published as usual.

In BENGAL, ten leaflets and one bulletin embodying departmental recommendations on different subjects were published and widely circulated amongst cultivators and the interested public.

In the UNITED PROVINCES, the Department of Agriculture issued fifteen leaflets and bulletins, of which four dealt with fruit culture. The departmental magazines *Kisan Upkarak* (Hindi) and *Mufidul-Mazarain* (Urdu) continued to be issued. The *Allahabad Farmer*, published by the Allahabad Agricultural Institute, appeared bi-monthly and was popular.

The PUNJAB Department of Agriculture continued to issue *Seasonal Notes* half-yearly. The *Lyallpur Agricultural College Magazine* entered its fourth year of existence. The Punjab Provincial Co-operative Fruit Development Board issued during the year the first two numbers of a quarterly bi-lingual (English and Urdu) publication called the *Punjab Fruit Journal*. The Journal aims at building up a fruit industry in the Punjab on a scientific, economic and progressive basis by disseminating information on fruit culture and the fruit industry in as non-technical a language as possible.

In BIHAR, the Department of Agriculture issued ten publications during the year in addition to the usual statistical information dealing with crops and rainfall. The publications were distributed widely througout the province.

In the CENTRAL PROVINCES AND BERAR, the Department issued nine leaflets and six other publications. The *Nagpur Agricultural College Magazine* was published quarterly as usual.

In the NORTH-WEST FRONTIER PROVINCE, the Department of Agriculture issued fortnightly letters to Revenue, Canal and Co-operative officials and to permanent zamindars and members of local bodies in which the main lessons which the Department

desired to demonstrate were stated in simple language. Over 1,000 copies of such letters were distributed.

In SIND, the Department issued a publication entitled ' Summary of Work of the Agricultural Department in Sind and a Five-year Programme of Development '.

The Director of Development, ORISSA, issued two bulletins on general agriculture and two others on crop pests.

In BALUCHISTAN, the Department of Agriculture published two leaflets in vernacular—one on the control of ' tid ' and the other on the control of bunt of wheat for free distribution to farmers.

The *Hyderabad Farmer*, issued by the Hyderabad Farming Association, was published quarterly. The English quarterly and the Kannada monthly published by the Agricultural and Experimental Union, MYSORE, continued to be popular. In BARODA, in addition to three leaflets on fruit and one agricultural almanac, twelve ' Notes to Farmers ' were printed and translated. The Department of Agriculture and Fisheries, TRAVANCORE, published eight leaflets during the year.

CHAPTER XVI

RECEIPTS AND EXPENDITURE OF THE AGRICULTURAL AND VETERINARY DEPARTMENTS

THE financial aspects of the Agricultural and Veterinary Departments of the Central, Provincial and State Governments during 1936-37 are summarised in Statements 1 and 2. Statements 3A and 3B show the figures analysed under various sub-heads.

The total gross expenditure of the Central and Provincial Departments of Agriculture has risen from Rs. 132·8 lakhs in 1935-36 to Rs. 150·7 lakhs in 1936-37. A rise of nearly Rs. 18 lakhs in the total expenditure of the Agricultural Departments is encouraging. The total gross expenditure of the Central and Provincial Veterinary Departments has increased from Rs. 68·4 lakhs to Rs. 73·3 lakhs, thus showing a rise of nearly Rs. 5 lakhs.

STATEMENT 1

Receipts and expenditure of the Agricultural Departments in India for 1935-36 and 1936-37

—	1935-36		1936-37	
	Receipts	Expenditure	Receipts	Expenditure
British India				
	Rs.	Rs.	Rs.	Rs.
Imperial Agricultural Research Institute, New Delhi.	93,393	6,75,360 (a)	62,436	8,74,050 (a)
Imperial Dairy Expert, Bangalore	1,17,648	1,95,962	1,14,463	2,06,528
Madras	1,91,168	18,57,827	1,88,792	19,54,180
Bombay	2,06,698	11,69,996	2,07,539	11,43,207
Bengal	66,794	8,95,153	58,588	8,49,882
United Provinces	3,82,807	20,85,311	4,19,686	24,50,385
Punjab	8,47,439	28,01,669	11,98,263	32,66,157
Bihar	1,85,530 (b)	6,65,880 (b)	1,26,351 (c)	10,22,521 (c)
Central Provinces and Berar	2,18,020	10,30,196	2,33,992	10,71,338
Assam	56,315	4,40,486	58,616	4,81,112
Orissa	..	..	25,435	1,02,194
N.-W. F. Province	70,574	1,69,105	70,742	1,71,775
Sind	43,655	3,85,756	79,055	5,13,318
Baluchistan	2,511	43,542	7,760	56,038
Burma	1,48,432	8,71,189	2,38,325	9,13,850
TOTAL	26,30,979	1,32,87,432	30,90,043	1,50,76,535
Indian States				
Hyderabad	36,655	7,92,899	46,853	8,25,219
Mysore	60,863	7,40,647	46,219	7,23,487
Baroda	33,972	3,08,004	36,214	4,30,226
Travancore	9,043	1,33,973	9,331	1,25,371
Cochin	16,970	86,892	21,033	84,948
Bhopal	5,482	54,484	10,903	48,670
Gwalior	36,989	64,312	44,710	59,373
Jammu and Kashmir	70,000	1,16,300	70,000	1,35,900

(a) Excludes expenditure of Rs. 56,358 during 1935-36 and Rs. 88,376 during 1936-37 in connection with the various research schemes financed by the Imperial Council of Agricultural Research.
(b) Inclusive of the figures for Orissa.
(c) Exclusive of the figures for Orissa.

STATEMENT 2

Receipts and expenditure of the Civil Veterinary Departments in India during 1935-36 and 1936-37

	1935-36		1936-37	
	Receipts	Expenditure	Receipts	Expenditure
British India				
	Rs.	Rs.	Rs.	Rs.
Imperial Institute of Veterinary Research	5,41,411	5,88,255	5,22,699	7,28,591
Madras	49,985	9,79,272	53,972	10,12,616
Bombay	21,199	4,87,880	20,842	4,98,189
Sind	366	1,13,720	483	1,22,282
Bengal	87,000	2,26,614	88,000	2,47,555
United Provinces	1,29,020	4,27,341	1,30,525	4,49,707
Punjab	1,26,356	20,23,024*	1,42,160	21,47,472*
Bihar	1,73,460	7,22,899	1,80,559	6,94,554
Orissa	(Figures not available as the province was created from 1st April 1936.)		19,024	89,396
Central Provinces and Berar	1,973	4,05,508	1,910	4,07,049
Assam	1,342	1,83,097	1,333	1,83,894
N.-W. F. Province	4,600	1,24,500	4,838	1,41,800
Baluchistan	..	63,686	..	63,389
Coorg	62	18,473	62	21,878
Ajmer-Merwara	..	10,764	..	11,546
Burma	2,032	4,71,278	17,192	5,15,216
TOTAL	11,38,806	68,46,320	11,83,599	73,35,134
Indian States				
Hyderabad	10,557	4,04,789	..	4,87,740
Mysore	11,606	2,52,885	23,154	2,62,390
Baroda	1,975	79,651	1,698	87,121
Travancore	335	35,320	265	33,961
Cochin	..	31,367	..	31,136
Bhopal	9,523	9,523	15,511	15,511
Jammu and Kashmir	..	58,663	..	79,895

* The figures of expenditure shown here include the provision made by Local Bodies of the Province for veterinary objects.

STATEMENT 3-A

Receipts and expenditure of Agricultural Departments in India during 1935-36 and 1936-37 (Classified)

—	EXPENDITURE								RECEIPTS					
	Crops and Soils		Education		*Animal Husbandry		TOTAL		Crops and Soils		Animal Husbandry†		TOTAL.	
	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
British India														
Imperial Agricultural Research Institute, New Delhi, and its Sub-stations.	5,61,511	7,64,564 (a)	(b)	(b)	1,18,811	109,468	6,75,322	8,74,050	54,201	37,510	39,192	24,926	93,393	62,436
Imperial Dairy Department.	..	..	..	..	..	..	1,95,962	2,06,528	..	..	..	..	1,17,643	1,14,463
Madras . . .	15,87,929	16,98,216	1,63,729	1,49,818	1,06,169	1,06,146	18,57,827	19,54,180	1,75,711	1,72,885	15,457	15,907	1,91,168	1,88,792
Bombay. . .	8,68,928	8,25,894	1,49,008	1,62,915	1,52,060	1,54,524	11,69,996	11,43,333	95,136	97,524	73,699	63,068	1,68,835	1,60,592
Bengal . . .	8,22,211	8,50,076	9,781	11,389	62,452	2,28,478 (c)	8,94,444	10,89,943 (c)	60,514	57,525	6,280	7,800	66,794	65,325
United Provinces .	(Not available)		3,76,405	3,66,673	1,07,261	1,47,254	4,83,666	5,13,927	(Not available)		44,097	62,386	44,097	62,386
Punjab . . .	26,10,719	30,59,009	1,79,824	1,95,792	11,126	11,356	28,01,669	32,66,157	8,46,306	11,95,897	1,133	674	8,47,439	11,96,571
Bihar . . .	6,65,112	10,22,521	767	..	..	..	6,65,880	10,22,521	1,85,530	1,26,351	..	..	1,85,530	1,26,351
Central Provinces and Berar.	8,60,235	8,72,139	71,090	98,581	98,871	1,00,618	10,30,196	10,71,338	1,70,604 (d)	1,78,624 (e)	47,416	55,368	2,18,020	2,33,992
Assam . . .	3,20,789	3,51,452	6,722	9,021	1,12,975	1,20,638	4,40,486	4,81,111	36,168	33,975	20,147	24,604	56,315	58,579

N.-W. F. Province .	69,810	1,14,349	1,020	600	..	..	70,830	1,14,949	33,031	45,268	..	..	33,031	45,268
Orissa . . .	..	1,00,013	..	..	..	2,181	..	1,02,194	..	22,637	..	2,798	..	25,435
Sind . . .	3,74,011	5,40,205	..	1,954	11,745	19,113	3,85,756	5,61,272	40,035	75,555	3,620	3,500	43,655	79,055
Baluchistan . .	276	289	2,837	2,981	3,350	4,000	3,350	4,000	1,003	974	..	..	1,003	974
Burma . . .	8,08,352	8,38,728	13,621	13,855	3,370	4,184	8,25,334	8,56,767	1,45,072	2,35,262	2,460	3,063	1,48,432	2,38,325
Indian States														
Hyderabad . .	7,22,907	7,54,800	26,210	26,210	43,782	44,209	7,92,899	8,25,219	26,205	39,280	10,450	7,573	36,655	46,853
Jammu and Kashmir	..	..	..	..	..	..	1,16,300	1,35,900	..	..	..	..	70,000 (*f*)	70,000 (*f*)
Mysore . . .	3,77,971	3,87,329	26,186	26,561	3,36,490	3,09,597	7,40,647	7,23,487	22,706	19,719	38,157	26,500	60,863	46,219
Baroda . . .	2,18,705	2,90,773	4,294	12,224	75,005	1,27,260	3,08,004	4,30,226	23,387	26,459	10,585	9,755	33,972	36,214
Travancore . .	87,683	81,010	10,306	9,108	35,972	34,723	1,33,961	1,24,841	8,813	9,109	230	222	9,043	9,331
Cochin . . .	13,480	12,255	5,267	4,745	9,875	10,501	28,622	27,500	10,048	11,075	3,510	4,252	13,558	15,327
Gwalior † . .	15,218	15,299	..	..	49,094	44,075	64,312	59,373	9,078	15,662	27,911	29,048	36,989	44,710
Bhopal (*g*) . .	54,484	47,670	..	1,000	10,161	15,511	64,645	64,181	5,481	10,902	..	..	5,481	10,902

* This shows the expenditure from Agricultural Department budget on account of livestock officers and their staff, live-stock farms, distribution of stud bulls, cattle fairs and shows and other measures pursued for the improvement of live-stock.

† Income from live-stock farms and other activities of Agricultural Department in connection with live-stock improvement.

(*a*) Includes expenditure on transfer of the Institute from Pusa to New Delhi.

(*b*) As the research and educational activities are combined, it is not possible to separate figures for education. The total expenditure represents, therefore, the cost of both research and education.

(*c*) Includes expenditure of Rs. 164,481 from the Government of India grant for rural uplift.

(*d*) Includes Rs. 24,573 as receipts from "education".

(*e*) Includes Rs. 23,087 as receipts from "education".

(*f*) The receipts are from the Agriculture (Proper) Department only.

(*g*) Cattle fairs are arranged by Mela officer, expenditure for which comes to Rs. 1,200 and income Rs. 1,862 for 1936-37.

STATEMENT 3-B

Receipts and expenditure of Veterinary Departments in India during 1935-36 and 1936-37
(Classified)

	EXPENDITURE								RECEIPTS					
	Disease Control		Education		*Livestock improvement		TOTAL		Live-stock Farms		Other Sources		TOTAL	
	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37
British India														
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Madras . . .	3,25,155	3,26,312	1,08,866	1,18,027	..	..	4,34,021	4,44,339	..	..	49,985	53,972	49,985	53,972
Bombay . . .	4,46,125	4,56,519	65,605	66,396	..	..	5,11,730	5,22,915	..	..	20,995	20,782	20,995	20,782
Bengal . . .	2,26,614	2,47,555	..	..	..	..	2,26,614	2,47,555	..	..	87,000	88,000	87,000	88,000
United Provinces .	3,82,928	4,14,761	9,860	12,197	34,553	22,749	4,27,341	4,49,707	..	..	..	..	1,29,020	(f) 1,30,525
Punjab (a) . .	8,70,265	10,06,799	1,67,079	1,58,025	9,85,680	9,82,648	20,23,024	21,47,472	98,984	1,02,877	27,372	39,283	1,26,356	1,42,160
Bihar . . .	1,59,003	1,40,650	78,973	83,183	(b) 53,151	53,915	2,91,127	2,77,748	(c) 63,378	62,504	..	..	63,378	62,504
Central Provinces and Berar.	3,82,942	3,97,890	..	..	89,318	96,238	4,72,260	4,94,128	37,697	40,519	1,973	1,910	39,670	42,429
Assam . . .	1,81,527	1,80,522	1,570	(d) 3,372	..	..	1,83,097	1,83,894	..	..	1,342	1,333	1,342	1,333
N.-W. F. Province .	98,029	1,05,100	6,365	7,000	24,695	29,000	1,29,089	1,41,100	..	..	5,633	5,000	5,633	5,000

Orissa (*e*) . .	..	89,396	..	..	..	..	..	89,396	..	..	..	10,024	..	10,024
Sind . . .	1,09,836	1,15,058	..	748	..	..	1,09,836	1,15,806	..	..	366	483	366	483
Baluchistan . .	5,911	5,961	..	..	3,350	4,000	9,261	9,961	..	..	..	..	..	..
Ajmer-Merwara .	10,764	11,546	..	..	..	..	10,764	11,546	..	..	..	..	..	..
Burma . . .	32,789	16,310	24,764	26,330	..	..	57,553	42,640	..	..	2,032	17,192	2,032	17,192

Indian States

Hyderabad . .	3,53,845	..	3,549	..	1,37,395	..	4,94,789	..	9,108	..	1,449	..	10,557	..
Kashmir . .	53,275	59,857	..	..	5,388	20,038	58,663	79,895	..	..	..	..	..	..
Mysore . . .	..	..	..	..	63,223	67,033	63,223	67,033	27,164	27,105	30,738	20,883	57,902	47,988
Baroda . . .	(Figures not available)				..	..	85,005	1,18,030	..	..	..	..	10,585	9,755
Travancore . .	..	..	..	..	..	..	35,984	33,605	..	..	..	..	230	222
Cochin . . .	8,120	8,097	..	..	..	..	8,120	8,097	..	..	..	..	..	..
Bhopal . . .	2,742	5,196	355	..	7,064	10,315	10,161	15,511	..	..	..	..	..	..
Coorg . . .	17,489	19,363	..	..	984	(*g*) 2,514	18,473	21,878	..	..	62	62	62	62

* This shows the expenditure on Farms, officers and staff engaged on live-stock improvement work, cattle fairs, shows, etc.

(*a*) The figures of expenditure shown here include the provision made by Local Bodies of the province for veterinary objects.

(*b*) Live-stock improvement is under the control of the Agricultural Department in this province. These figures represent the expenditure of the Government Cattle Farm, Patna, which is only under this Department.

(*c*) For the Government Cattle Farm, Patna.

(*d*) As there is no institution in this province for veterinary education the amount shown under head "education" represents expenditure incurred on account of the Government stipendiaries of this province at the Bengal Veterinary College, Calcutta, including the Assam Government contribution of Rs. 600 per stipendiary per annum, to the Bengal Veterinary College.

(*e*) Figures for 1935-36 are not available, as the province was created on 1st April 1936.

(*f*) While the totals of receipts and expenditure are accurate, the details are only approximate.

(*g*) As the Veterinary Department itself is in charge of live-stock work, the expenditure shown under live-stock improvement includes the amount spent for awarding prizes at the cattle show, purchasing breeding bulls and maintaining them.

APPENDICES

APPENDIX I

Areas under new and improved varieties of crops in India during 1936-37

Name of Province or State	Name of crop	Area in Acres					
		1935-36			1936-37		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Madras	Paddy	31,411	1,031,888	1,063,299	23,758	1,371,285	1,395,043
	Cotton	70,268	547,674	617,942	48,864	553,875	602,739
	Sugarcane	9,012	49,037	58,049	711	48,805	49,516
	Miscellaneous	9,016	196,039	205,055	7,814	91,193	99,007
Bombay	Cotton	405,983	286,634	692,617	427,675	185,734	613,409
	Groundnut	322	52,175	52,497	465	49,734	50,199
	Wheat	5,559	20,312	25,871	5,531	44,836	50,367
	Sugarcane	110	13,850	13,960	431	18,108	18,539
	Bajra (Akola)	16,914	131,532	148,446	591	2,650	3,241
	Paddy	4,303	9,221	13,524	7,340	14,155	21,495
	Tobacco	880	2,500	3,380	107	2,500	2,607
	Sann seed	726	1,396	2,122	167	2,817	2,984
	Soya Beans	36	23	59	123	150	273
	Lucerne	100	1,903	2,003	200	1,586	1,786
	Nilwa	29	105	134	4	100	104
	Fruit	595	4,508	5,163	456	10,235	10,691
	Nagli	225	3,500	3,725	220	4,000	4,220

	Jowar	2,036	2,160	4,196	2,613	6,880	9,493
	Potato	55	50	105	1,235	1,990	3,225
	Miscellaneous	..	..	..	2	..	2
Bengal	Paddy	6,694*	699,161*	705,855*	13,295	762,989	776,284
	Jute	435*	1,095,040*	1,095,475*	1,167	1,300,277	1,301,444
	Sugarcane	3,770	273,756*	277,526*	2,745	325,071	327,816
	Other crops	2,107*	46,228*	48,335*	5,302	59,017	64,319
United Provinces	Wheat	187,000	2,450,000	2,637,000	236,000	2,637,000	2,873,000
	Cotton	40,000	357,000	397,000	48,000	397,000	445,000
	Sugarcane	120,000	2,047,000	2,167,000	111,000	1,862,500	1,973,500
	Barley	23,000	81,500	104,500	15,000	104,500	119,500
	Gram	21,000	131,200	152,200	19,000	152,200	171,200
	Miscellaneous	20,000	267,000	287,000	44,000	287,000	331,000
Punjab	Cotton	513,000	1,563,100	2,076,100	573,600	1,654,600	2,228,200
	Wheat	243,600	3,233,200	3,476,800	370,000	3,890,900	4,260,900
	Sugarcane	5,000	221,300	226,300	2,900	299,700	302,600
Bihar	Wheat	..	..	..	..	..	58,350
	Sugarcane	..	..	..	..	..	473,524
	Paddy	..	..	..	..	..	42,554
	Jute	..	..	..	..	..	300
	Barley	..	..	..	..	..	3,903
	Groundnut	..	..	..	..	..	1,852
	Tobacco	..	..	..	..	..	30
	Gram	..	..	..	..	..	4,274
	Miscellaneous	..	..	..	..	..	4,302

*Revised figures.

Areas under new and improved varieties of crops in India during 1936-37—contd.

Name of Province or State	Name of crop	Area in Acres					
		1935-36			1936-37		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Central Provinces and Berar	Wheat	..	..	590,025	..	..	649,687
	Rice	..	..	585,688*	..	..	667,733
	Cotton	..	..	505,327	..	..	476,923
	Jowar	..	..	178,103	..	..	218,672
	Groundnut	..	..	105,832	..	..	98,166
	Other crops	..	..	81,609	..	..	83,626
Assam	Rice	2,227	40,382	42,609	5,274	47,224	52,498
	Sugarcane	33	14,465	14,498	99	17,452	17,551
	Potato	190	5,709	5,899	55	8,837	8,892
	Jute	*Nil*	15,890	15,890	*Nil*	13,765	13,765
North-West Frontier Province	Wheat	15,473*	7,400*	22,873*	28,096	105,523	134,519
	Maize	3,405*	220*	3,625*	4,560	33,080	37,640
	Sugarcane	13,532*	2,400*	15,932*	10	2,500	2,510
	Cotton	400	500	900	1,162	250	1,412
	Gram	16	..	16	Not available.		
	Miscellaneous	32*	..	32*			
	Sugarcane	..	..	..	170	30,830	31,000
	Paddy	..	..	..	125	21,584	21,709

Orissa	Wheat	..	..	..	12	398	410
	Oilseeds	..	..	..	50	7,168	7,218
	Beans and pulses	..	..	..	38	3,028	3,066
	Potato	..	..	..	12	2,844	2,856
	Onion	..	..	..	5	6,609	6,614
	Miscellaneous	..	..	..	162	4,740	4,902
Sind	Wheat	69,718*	220,141*	289,854*	68,113	233,551	301,664
	Cotton	54,590*	371,935*	426,525*	74,663	421,774	496,437
	Rice	54,541*	175,959*	230,500*	83,889	258,466	342,355
	Miscellaneous	62,669*	113,847*	176,516*	62,924	84,245	147,169
Baluchistan	Wheat	..	..	900	..	..	900
Hyderabad	Sugarcane	670	16,883	17,553	531	8,620	9,151
	Groundnut	1,243	35,020	36,263	1,331	125,359	126,690
	Bajra	470	1,155	1,625	238	831	1,069
	Wheat	726	746	1,472	253	1,127	1,380
	Paddy	460	1,305	1,765	236	1,307	1,543
	Jowar	175	..	175	5	10	15
	Cotton	53,700	2,390	56,090	27,704	79,368	107,072
	Castor	400	..	400	187	232	419
	Potatoes	1	..	1	..	..	..
	Guinea grass	3	..	3	1	3	4
	Dhaincha	1	..	1	..	..	..
Mysore	Paddy	4,716	72,103	76,819	6,858	102,346	109,204
	Ragi	8,812	320,218	339,030	80,334	224,017	232,051
	Sugarcane	13,405	5,869	19,273	14,094	16,420	30,514

* Revised figures.

Areas under new and improved varieties of crops in India during 1936-37—contd.

Name of Province or State	Name of crop	Area in Acres					
		1935-36			1936-37		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Mysore—*contd.*	Groundnut	1,406	27,727	29,133	3,046	16,474	19,520
	Sunn-hemp	25	100	125	50	302	352
	Tobacco	300	..	300	..	967	967
	Jola	15	2,495	2,510	..	46,898	46,898
	Cotton	3,421	9,263	12,684	6,880	15,108	21,988
	Vegetable seeds	..	..	..	12	21	33
	Pepper cuttings	..	..	..	..	20	20
	Chillies	1	5	6	1	3	4
	Soya Beans	6	..	6	..	..	..
	Java wheat	2	..	2	1	..	1
	Miscellaneous	..	..	..	..	5	5
Baroda	Cotton	74,997*	9,933*	84,930*	40,014	19,680	59,694
	Rice	143*	5,810*	5,953*	239	6,510	6,749
	Wheat	67*	10,030*	10,097*	195	12,050	12,245
	Groundnut	1*	6*	7*	50	14	64
	Miscellaneous	72*	50*	122*	82	85	167
Travancore	Paddy	311	..	311	304	..	304
	Paddy	139*	160*	299*	110	295	405
	Sugarcane	40*	16*	56*	40	35	75

Cochin	Cotton	..	4,644*	4,644*	..	5,200	5,200
	Pine-apple	..	50	50	..	50	50
	Coconuts	9	37	46	32	46	78
	Groundnut	..	1	1	..	4	4
	Miscellaneous	..	8*	8*	..	10	10
Bhopal	Cotton	11*	5	16*	17	30	47
	Paddy	1	5	6	2	8	10
	Wheat	1,500	19,732	21,232	3,000	59,196	62,196
	Gram	302	200	502	1,000	1,200	2,200
	Linseed	110	200	310	250	1,000	1,250
	Til	31	510	541	100	1,500	1,600
	Sugarcane	16,000 (canes)	..	1,600 (canes)	2,000 (canes)	1,800 (canes)	3,800 (canes)
	Groundnut	7	10	17	50	40	90
	Castor	10	250	260	5	5	10
	Peas	20	10	30	100	100	200
	Tobacco	5	20	25	7	25	32
	Miscellaneous	25	30	55	105	300	405
Gwalior	*Jowar*	..	..	..	17,141	56,631	73,772
	Bajra	..	..	..	142	11,538	11,680
	Cotton	..	..	..	3,280	13,026	16,306
	Paddy	..	..	..	191	156	347
	Sesamum	..	..	..	162	1,161	1,323
	Arhar	..	..	..	311	846	1,157
	Groundnut	...	..	..	9	881	890
	Sugarcane	..	..	..	865	3,204	4,069
	Wheat	..	..	..	6,301	51,923	58,224

*Revised figures.

Areas under new and improved varieties of crops in India during 1936-37—concld.

Name of Province or State	Name of crop	Area in Acres					
		1935-36			1936-37		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Gwalior—*contd.*	Gram	..	..	..	1,254	2,455	3,709
	Linseed	..	..	..	601	3,801	4,402
	Barley	..	..	..	51	77	128
	Miscellaneous	..	..	..	275	9,646	9,921
Jammu and Kashmir	Rice	450	8,000	8,450	707	9,000	9,707
	Wheat	272	10,000	10,272	370	15,000	15,370
	Barley	17	100	117	19	200	219
	Indian corn	900	20,000	20,900	535	30,000	30,535
	Sugar corn	171	700	871	196	900	1,096
	Oil-seeds	38	200	238	40	250	290
	Potatoes	24	500	524	3	600	603
	Beans	73	200	273	31	600	631
	Peas	79	400	479	56	800	856
	Sugarcane	40	2,500	2,540	10	2,500	2,510
	Vegetable seeds	400	1,000	1,400	279	1,500	1,779
	Miscellaneous crops	200	500	700	118	1,000	1,118
	Paddy	183,863	874,921	1,058,784	229,470	914,293	1,143,763
	Groundnut	651	21,056	21,707	2,188	41,866	44,054
	Gram	4,298	170,163	174,461	1,878	180,540	182,418

Burma	Wheat	140	24,150	24,290	240	19,200	19,340
	Cotton	4,212	1,472	5,694	4,331	1,649	5,980
	Jowar	1,000	2,027	3,687	785	2,765	3,550
	Butter beans	650	5,400	6,050	596	12,900	13,496
	Peningon	4,108	79,500	83,608	6,608	66,698	73,306
	Sugarcane	288	15,900	16,197	16,010	15,146	31,105
	Sesamum	2,502	21,720	24,312	2,188	26,741	28,929
	Maize	155	300	455	1,054	165	1,219
	Red onion	..	1,515	1,515	1,752	15	1,767
	Kew pine-apple	3	..	3	6	2	8
	Maize	..	..	..	408	153	556
	Pelun	..	..	..	2	..	2
	Miscellaneous	1,161	6,228	6,374	1,072	9,030	10,102

APPENDIX II (*a*)

List of Agricultural Stations in India in 1936-37

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
British India					
Imperial Department of Agriculture.	New Delhi	377*	Assistant Agriculturist	Imperial Agriculturist	Imperial Agricultural Research Institute.
	Karnal	1,160*	Cattle Superintendent	Ditto	Agricultural Sub-station and Cattle-Breeding Farm.
	Coimbatore	90	Farm Manager	Sugarcane Expert	Sugarcane Breeding Station.
	Pusa	200	Superintendent	Imperial Economic Botanist	Botanical Sub-station financed by the Imperial Council of Agricultural Research.
	Guntur	20	Ditto	Ditto	Tobacco Sub-station financed by the Imperial Council of Agricultural Research.
	Simla	23	Ditto	Ditto	Potato Breeding Sub-station financed by the Imperial Council of Agricultural Research.
	Karnal	50	Assistant	Sugarcane Expert	Sugarcane Sub-station financed by the Imperial Council of Agricultural Research.
	Imperial Dairy Institute, Bangalore	193	Superintendent, Imperial Dairy Institute, Bangalore.	Imperial Dairy Expert, Bangalore.	
	Milk Depôt, Wellington	69	Supervisor-in-charge, Milk Depot, Wellington.	Ditto.	
	Samalkota	57	Farm Manager	Deputy Director of Agriculture, I Circle, Vizagapatam.	
	Anakapalle	104	Superintendent	Ditto.	

Madras	Marutera	50	Ditto		Paddy Specialist, Coimbatore.
	Guntur	150	Farm Manager		Deputy Director of Agriculture, II Circle, Guntur.
	Hagari	225	Superintendent		Deputy Director of Agriculture, III Circle, Bellary.
	Nandyal	88	Farm Manager		Ditto.
	Anantarajupet	50	Superintendent		Ditto.
	Gudiyattam	35	Farm Manager		Superintendent, Agricultural Research Station, Anakapalle.
	Kalahasti	30	Ditto		Deputy Director of Agriculture, IV Circle, St. Thomas Mount.
	Erayanur, Tindivanam	49	Superintendent		Oil-seeds Specialist, Coimbatore.
	Palur	52	Farm Manager		Deputy Director of Agriculture, IV Circle, St. Thomas Mount.
	Aduturai	50	Superintendent		Deputy Director of Agriculture, V Circle, Trichinopoly.
	Patbukkottai	36	Farm Manager		Ditto.
	Kollpatti	140	Superintendent		Deputy Director of Agriculture, VI Circle, Madura.
	Pattambi	82	Ditto		Paddy Specialist, Coimbatore.
	Taliparamba	36	Farm Manager		Deputy Director of Agriculture, VII Circle, Tellicherry.
	Kasaragod and Nileshwar	178	Ditto		Oil-seeds Specialist, Coimbatore.
	Nanjanad	160	Superintendent		Deputy Director of Agriculture, VIII Circle, Coimbatore.

* Cultivated area.

List of Agricultural Stations in India in 1936-37—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Madras—*contd.*	Coonoor, Burliar and Kallar	80	Farm Manager	Curator, Government Botanical Gardens, Ootacamund.	Pomological Stations.
	Coimbatore	400	Superintendent	Principal, Agricultural College, Coimbatore.	
	Hosur	1,660	Ditto	Deputy Director of Agriculture, Live-stock, Hosur Cattle Farm P. O.	
	Buchireddipalem	10	Farm Manager	Deputy Director of Agriculture, II Circle, Guntur.	
	Ambasamudram	10	Ditto	Deputy Director of Agriculture, VI Circle, Madura.	
	Berhampore	38	Superintendent	Paddy Specialist, Coimbatore.	
	Jalgaon	107	Superintendent, Jalgaon Farm.	Deputy Director of Agriculture, North Central Division, Nasik.	
	Bhadgaon	230	Superintendent, Bhadgaon Farm.	Ditto.	
	Dhulia	28	Head Master, Dhulia Agricultural School, Dhulia.	Ditto	Agricultural School.
	Karjat	15	Rice Specialist, Karjat	Ditto.	
	Kopargaon	110	Superintendent, Kopargaon Farm, Kopargaon.	Deputy Director of Agriculture, South Central Division, Poona.	Sugarcane experimental and confirmation station.
	Ratnagiri	22	Superintendent, Ratnagiri Farm, Ratnagiri.	Ditto	Rice and Nagli Breeding Stations.
	Hatkhamba	71	Ditto	Ditto	
	Mohol	55	Superintendent, Mohol Farm, Mohol.	Ditto	This farm is maintained for testing and showing methods of dry farming and land development in famine area.

Bombay	Dharwar	146	Superintendent, Dharwar Farm, Dharwar.	Deputy Director of Agriculture, South Division, Dharwar.	
	Gokak Canal Farm, Arbhavi	62	Superintendent, Gokak Canal Farm, Arbhavi.	Ditto.	
	Kumpta	68	Superintendent, Kumpta Farm.	Ditto.	
	Rice Breeding Station, Mugad	9	Rice Breeder, Mugad	Ditto.	
	Cattle Breeding Farm, Tegur	370	Manager, Cattle Breeding Farm, Tegur.	Ditto.	
	Surat	295	(1) Superintendent, Agricultural Station, Surat. (2) Cotton Breeder, South Gujarat, Surat.	Deputy Director of Agriculture, Gujarat, Surat.	
	Nadiad	18	Tobacco Breeder, Nadiad	Ditto.	
	Broach	28	1. Superintendent, Broach Farm, Broach. 2. Cotton Breeder, Broach	Ditto.	
	Dohad	68	Superintendent, Dohad Farm.	Ditto.	
	Viramgam	13	Cotton Breeder, North Gujarat, Viramgam.	Ditto.	
	Agricultural College Farm, Poona	275	Supreintendent, Agricultural College Farm, Poona.	Professor of Agriculture, Agricultural College, Poona.	
	Agricultural College Dairy, Kirkee	362	Manager, Agricultural College Dairy, Kirkee.	Ditto.	
	Rice Breeding Station, Karjat	4*	Superintendent, Rice Breeding Station, Karjat.	Crop Botanist to Government, Bombay Presidency, Karjat.	*Areas under actual cultivation.
	Cereal Breeding Station, Niphad	16*	Superintendent, Cereal Breeding Station, Niphad.	Ditto	*Ditto.
	Northcote Cattle Breeding Farm, Chharodi.	2,279	Manager, Northcote Cattle Breeding Farm, Chharodi.	Live-stock Expert to Government, Bombay Presidency, Poona.	
	Cattle Breeding Farm, Bankapur	97* 153**	Manager, Cattle Breeding Farm, Bankapur.	Live-stock Expert to Government, Bombay Presidency, Poona.	*Farm area. **Grazing area at Kalasgeri attached to the farm.

List of Agricultural Stations in India in 1936-37—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Bombay—*contd.*	Ganeshkhind Fruit Experiment Station, Kirkee.	80	Superintendent, Ganeshkhind Fruit Experiment Station, Kirkee.	Horticulturist to Government, Bombay Presidency, Poona.	
	Modibag, Agricultural College, Poona	12	Superintendent, Modibag, Agricultural College, Poona.	Ditto	This is now converted into a commercial fruit farm.
	Samarkha, Kasor and Nisaraya, *vid* Anand.	224	Investigator in Agricultural Economics, Agricultural College, Poona.	Professor of Agricultural Economics, Agricultural College, Poona.	Cost accounting of mixed farming with live-stock raising.
	Dacca Central Farm	354	Superintendent of Agriculture.	Deputy Director of Agriculture, Eastern Circle.	Extra about 300 acres of land acquired for Agricultural Institute. Lowland under cultivation on borga and part of high land for cane breeding is used.
	Joydebpur	13	Agricultural Demonstrator	District Agricultural Officer, Dacca.	Agricultural Demonstrator by Bhowal Estate.
	Mymensingh District Farm	20	District Agricultural Officer.	Deputy Director of Agriculture, Eastern Circle.	
	Jamalpur	35	Ditto	Ditto	Run on borga.
	Kishoreganj	88	Ditto	Ditto	Ditto.
	Dhanbari	7	Ditto	Ditto	Ditto.
	Mahinanda	37	Ditto	Ditto	Run on borga and the supervision of Sub-divisional Officer, Kishoreganj on Khasmahal land. District Agricultural Officer gives advice.
	Gayhatta	6	Agricultural Demonstrator, Gayhatta.	District Agricultural Officer, Mymensingh.	Court of Wards Farm.
	Baratia	8	Agricultural Demonstrator, Baratia.	Ditto	Private.

Bengal	Faridpur District Farm	20	District Agricultural Officer, Faridpur.	Deputy Director of Agriculture, Eastern Circle.	
	Rajbari Farm	10	Ditto	Ditto	Run on borga.
	Barisal District Farm	20	District Agricultural Officer, Barisal.	Ditto.	
	Charbadna Farm	66	Ditto	Ditto	Run on borga.
	Comilla District Farm	20	District Agricultural Officer, Comilla.	Ditto.	
	Brahmanbaria Farm	5	Agricultural Demonstrator, Brahmanbaria.	District Agricultural Officer, Comilla.	Private.
	Rajshahi Farm	63	Farm Superintendent, Rajshahi.	Deputy Director of Agriculture, Northern Circle.	
	Rangpur Demonstration Farm	19	District Agricultural Officer, Rangpur.	Ditto.	
	Dinajpur Farm	24	District Agricultural Officer, Dinajpur.	Ditto.	
	Pabna Farm	19	District Agricultural Officer, Pabna.	Ditto.	
	Bogra Main Farm	23	District Agricultural Officer, Bogra.	Ditto.	
	Bogra Branch Farm	7	Ditto	Ditto.	
	Mainaguri Farm	25	District Agricultural Officer, Jalpaiguri.	Ditto.	
	Malda Farm	16	District Agricultural Officer, Malda.	Ditto.	
	Burirhat Farm.	72	Farm Superintendent, Burirhat.	Assistant Director of Agriculture.	
	Chinsurah	210	Farm Superintendent, Chinsurah.	Deputy Director of Agriculture, Western Circle.	
	Burdwan	24	District Agricultural Officer, Burdwan.	Ditto.	
	Bankura	29	District Agricultural Officer, Bankura.	Ditto.	
	Suri	35	District Agricultural Officer, Birbhum.	Ditto.	
	Berhampore	44	District Agricultural Officer, Berhampore.	Ditto.	

List of Agricultural Stations in India in 1936-37—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Bengal—*contd.*	Krishnagar	53	District Agricultural Officer, Nadia.	Deputy Director of Agriculture, Western Circle.	
	Jessore Khasmahal	5	District Agricultural Officer, Jessore.	Ditto.	
	Kalimpong Farm	73	Superintendent of Agriculture, Darjeeling.	Director of Agriculture, Bengal.	
	Rangamati Farm (Hill Tracts)	36	District Agricultural Officer, Chittagong Hill Tracts.	Ditto	Terrace cultivation has been found successful.
	Shahjahanpur	165	Economic Botanist	Economic Botanist (Sugarcane and Paddy) to Government, U. P.	
	Nagina	76	Assistant Paddy Specialist	Ditto.	
	Budaun	20	Farm Superintendent	Deputy Director of Agriculture, Rohilkhand and Kumaun Circle, Bareilly.	
	Nawabganj	120	Ditto	Ditto.	
	Nigohi farm	35	Ditto	Ditto.	
	Jeolikote	51	Ditto	Ditto.	
	Tarikhet	17	Ditto	Ditto.	
	Atarra	171	Ditto	Divisional Superintendent of Agriculture, Bundelkhand Circle.	
	Bela Tal	31	Ditto	Ditto.	
	Etawah	61	Ditto	Ditto.	
	Bichpuri	100	Ditto	Ditto.	
	Fyzabad	206	Ditto	Deputy Director of Agriculture, Eastern Circle.	
	Partabgarh	90	Ditto	Ditto.	

United Provinces	Benares	78	Ditto	Divisional Superintendent of Agriculture, Eastern Circle.
	Kalai	143	Ditto	Deputy Director of Agriculture, Western Circle.
	Bulandshahr	25	Ditto	Ditto.
	Muzaffarnagar	106	Cane Agronomist, Muzaffarnagar.	1. Economic Botanist (Sugarcane to Government, U. P.) 2. Entomologist to Government, U. P. 3. Deputy Director of Agriculture, Western Circle.
	Meerut	76	Farm Superintendent	Assistant Director of Agriculture, Western Circle.
	Mainpuri	53	Ditto	Divisional Superintendent of Agriculture, Western Circle.
	Farrukhabad	10	Ditto	Deputy Director of Agriculture, Western Circle.
	Gorakhpur	110	Ditto	Deputy Director of Agriculture, North-Eastern Circle.
	Bahraich	102	Ditto	Divisional Superintendent of Agriculture, North-Eastern Circle.
	Kalianpur	222	Ditto	Deputy Director of Agriculture, Sarda Circle, Lucknow.
	Hardoi	50	Ditto	Divisional Superintendent of Agriculture, Sarda Circle.
	Haidergarh (Model Farm)	27	Ditto	Ditto.
	Barabanki (Model Farm)	27	Ditto	Ditto.
	Turner (Rae Bareli)	10	Ditto	Ditto.
	Unao	38	Ditto	Ditto.
	Research Farm, Cawnpore	97	Ditto	Officer-in-charge, Research Farm.

List of Agricultural Stations in India in 1936-37—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
United Provinces—*contd.*	Raya (Muttra)	154	Farm Superintendent	Economic Botanist (Cotton).	
	Bharari Cattle Farm, Jhansi	2,241	Ditto	Agricultural Inspector.	
	Madhurikund Cattle Farm, Muttra	1,396	Ditto	Divisional Superintendent of Agriculture, Agra.	
	Manjhra Cattle Farm, Kheri	550	Ditto	Deputy Director of Agriculture, Bundelkhand Circle.	
	Hempur Cattle Farm, Naini Tal.	7,192	Ditto	Ditto.	
	Lyallpur Agricultural Station	431	Agricultural Assistant	Deputy Director of Agriculture, Lyallpur.	Experimental Farm.
	Botanical Farm, Lyallpur	34	Cerealist	Cerealist, Punjab Agricultural College, Layallpur.	Experiments with cereals.
	Cotton Research Station, Lyallpur	18	Cotton Research Botanist, Lyallpur.	Cotton Research Botanist, Lyallpur.	Breeding plot.
	Cotton Research Farm, Risalewala	230	Assistant to Cotton Research Botanist, Lyallpur.	Ditto	Agronomic and extensive trials.
	Cotton Research Sub-station, Multan	25	Agricultural Assistant	Ditto	Breeding and agronomic trials.
	Students' Farm, Lyallpur	82	Assistant Professor of Agriculture.	Associate Professor of Agriculture and Professor of Agriculture, Lyallpur.	For practical training to students.
	Dairy Farm, Lyallpur	35	Dairy Manager	Ditto	Ditto.
	Botanical Farm, Lyallpur	10	Professor of Botany	Professor of Botany, Punjab Agricultural College, Lyallpur.	For Root-rot experiments, spice crops and various diseases. Besides, there are seven acres under teaching collection area as Botanical garden.

Punjab	Fruit Farm, Lyallpur	28	Agricultural Assistant	Fruit Specialist, Lyallpur	Experiments with fruits.
	Risalewala	748	Ditto	Deputy Director of Agriculture, Lyallpur.	Mainly a seed farm.
	Jhang	200	Ditto	Ditto	District Farm.
	Kala Shah Kaku Rice Farm	390	Assistant Cerealist	Cerealist, Punjab Agricultural College, Lyallpur.	Rice Breeding Station.
	Montgomery Agricultural Station	681	Agricultural Assistant	Deputy Director of Agriculture, Montgomery.	Experimental Farm.
	Shergarh Farm	1,549	Ditto	Ditto	Seed Farm.
	Fatna Farm	528	Ditto	Ditto	Ditto.
	Yusufwala Farm	3,326	Ditto	Ditto	Ditto.
	Multan Farm	528	Ditto	Deputy Director of Agriculture, Multan.	Experimental and Seed Farm.
	Vihari Farm	500	Ditto	Ditto	Seed Farm.
	Gurdaspur Agricultural Station	268	Ditto	Deputy Director of Agriculture, Gurdaspur.	Experimental Farm.
	Beas Farm	36	Ditto	Ditto	District Farm.
	Attari Farm	101	Ditto	Ditto	Ditto.
	Gujranwala Farm	107	Ditto	Ditto	Ditto.
	Rawalpindi Agricultural Station	252	Ditto	Deputy Director of Agriculture, Rawalpindi.	Experimental Station.
	Campbellpur Farm	105	Ditto	Ditto	District Farm.
	Gujrat Farm	47	Ditto	Ditto	Ditto.
	Chillianwala Seed Farm	250	Ditto	Ditto	Seed Farm.
	Sargodha Old Seed Farm	155	Ditto	Ditto	Ditto.
	Sargodha New Seed Farm	492	Ditto	Ditto	Ditto.
	Mianwali Farm	162	Ditto	Ditto	District Farm.
	Hansi Agricultural Station	589	Ditto	Deputy Director of Agriculture, Hansi.	Experimental Station.
	Botanical Sub-station, Sirsa	145	Millet Botanist and Fodder Specialist.	Professor of Botany, Punjab Agricultural College, Lyallpur.	Botanical experiments.

List of Agricultural Stations in India in 1936-37—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Punjab—*contd.*	Gurgaon Farm	100	Agricultural Assistant	Deputy Director of Agriculture, Hansi.	District Farm.
	Rohtak Dry Farming Research Station	100	Agriculturist	Ditto	Dry Farming Research Station.
	Ambala Farm	100	Agricultural Assistant	Ditto	District Farm.
	Karnal Farm	100	Ditto	Ditto	Ditto.
	Ludhiana Farm	54	Ditto	Deputy Director of Agriculture, Jullundur.	Ditto.
	Kangra Agricultural Plot	10	Ditto	Ditto	Agricultural Plot.
	Jullundur Agricultural Station	121	Ditto	Ditto	Experimental Farm.
	Ferozepore Farm	100	Ditto	Ditto	District Farm.
Bihar	Sepaya	379	Manager	Deputy Director of Agriculture, Tirhut Range.	
	Pusa	1,278*	Ditto	Ditto	*Of which 80 acres have been allotted for the Sugarcane Research Station.
	Siwan	20	Overseer	Ditto.	
	Darbhanga	26	Ditto	Ditto.	
	Byreah	316	Manager	Ditto.	
	Patna	200	Ditto	Deputy Director of Agriculture, Bhagalpur Range.	
	Gaya	95	Overseer	Ditto.	
	Nawadah	88	Ditto	Ditto.	
	Bikramganj	24	Ditto	Ditto.	
	Siris	35	Ditto	Ditto.	

	Kanke	340	Manager	Deputy Director of Agriculture, Chota Nagpur Range.	
	Netarhat	193	Overseer	Ditto.	
	Purulia	52	Ditto	Ditto.	
	Chianki	32	Ditto	Ditto.	
	Chaibassa	38	Ditto	Ditto.	
	Sabour	150	Manager	Deputy Director of Agriculture, Bhagalpur Range.	
	Banka	26	Overseer	Ditto.	
	Jamui	38	Ditto	Ditto.	
	Purnea	60	Assistant Director of Agriculture.	Ditto.	
Central provinces and Berar	Experimental Farm, Akola	272	Superintendent	Economic Botanist for Cotton, Central Provinces.	
	Experimental Farm, Tharsa	116	Ditto	Deputy Director of Agriculture.	
	Experimental Farm, Chhindwara	69	Ditto	Ditto.	
	Experimental Farm, Powarkhera	528	Ditto	Ditto.	
	Experimental Farm, Adhartal	299	Ditto	Ditto.	
	Experimental Farm, Nagpur	236	Ditto	Principal, Agricultural College, Nagpur.	
	Experimental Farm, Labhandi	229	Ditto	Deputy Director of Agriculture.	
	Seed and Demonstration Farm, Warasconi.	68	Ditto	Ditto.	
	Seed and Demonstration Farm, Betul	160	Ditto	Ditto.	
	Seed and Demonstration Farm, Bilaspur.	258	Ditto	Ditto.	
	Seed and Demonstration Farm, Buldana.	185	Ditto	Ditto.	
	Seed and Demonstration Farm, Drug	281	Ditto	Ditto.	

List of Agricultural Stations in India in 1936-37—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Central Provinces and Berar —*contd.*	Seed and Demonstration Farm, Khandwa.	177	Superintendent	Deputy Director of Agriculture.	
	Seed and Demonstration Farm, Chandkhuri.	199†	Ditto	Ditto	†Cropped area.
	Seed and Demonstration Farm, Seoni	170	Ditto	Ditto.	
	Seed and Demonstration Farm, Yeotmal.	106	Ditto	Ditto.	
	Seed and Demonstration Farm, Saugor	161	Ditto	Ditto.	
	Seed and Demonstration Farm, Dindori	510	Ditto	Ditto.	
	Seed and Demonstration Farm, Sindewahi.	213	Ditto	Ditto.	
	Cattle Breeding Farm, Drug	‡	Ditto	Ditto	‡This Farm is attached to Demonstration Farm, Drug.
	Cattle Breeding and Dairy Farm, Ellichpur.	300	Ditto	Extra Assistant Director of Agriculture Incharge, Animal Husbandry Section.	
	Cattle Breeding Farm, Powarkhera	§	Ditto	Deputy Director of Agriculture.	§Attached to the Experimental Farm, Powarkhera.
	Cattle Breeding Farm, Adhartal	339	Ditto	Ditto.	
	Cattle Breeding and Dairy Farm, Telinkheri.	1,000	Ditto	Extra Assistant Director of Agriculture Incharge, Animal Husbandry Section.	
	Cattle Breeding Farm, Chandkhuri	‖	Ditto	Deputy Director of Agriculture.	‖Attached to the Seed and Demonstration Farm, Chandkhuri.
	Cattle Breeding Farm, Khandwa	¶	Ditto	Ditto	¶Attached to the Seed and Demonstration Farm, Khandwa.

	Cattle Breeding Farm, Garhi	1,617	Ditto	Extra Assistant Director of Agriculture Incharge, Animal Husbandry Section.		
	Cattle Breeding Farm, Pendra	2,500	Ditto	Ditto.		
	Cattle Breeding Farm, Bod	2,906	Ditto	Ditto.		
	Cattle Breeding Farm, Borgaon	879	Ditto	Deputy Director of Agriculture.		
	Cattle Breeding Farm, Bilaspur	**	Ditto	Ditto		**Attached to Seed and Demonstration Farm, Bilaspur.
	Upper Shillong Experimental Station	521	Farm Manager	Deputy Director of Agriculture, Live-stock.		Cattle breeding, potato and fodder crops.
	Khanapara Cattle Breeding Farm	197	Ditto	Ditto		Ditto.
	Sylhet Cattle Breeding Farm	210	Ditto	Ditto		Ditto.
Assam	Jorhat Experimental Station	59	Ditto	Deputy Director of Agriculture, Upper Assam Valley and Economic Botanist, Assam.		Cattle breeding and sugarcane crop.
	Titabar Experimental Station	125	Ditto	Economic Botanist, Assam		Rice.
	Karimganj Experimental Station	80	Ditto	Deputy Director of Agriculture, Surma Valley.		Rice.
	Deep Water Paddy Research Farm, Habiganj.	54	Ditto	Economic Botanist, Habiganj.		Deep Water Paddy.
	Fruit Experimental Station	63	Fruit Inspector	Director of Agriculture, Assam.		Fruit culture.
	Cuttack Farm	143	Manager	Deputy Director of Agriculture.		
	Angul Farm	47	Overseer			
	Kujang Farm	30	Ditto			
	Aul Farm	5	Sardar			
Orissa	Balia (Balasore) Farm	75	Overseer			
	Puri Farm	47	Sardar			
	Khurda Farm	43	Overseer			
	Sambalpur Farm	82	Ditto			

List of Agricultural Stations in India in 1936-37—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Orissa—*contd.*	Cuttack Rice Research Sub-station	7	First Research Assistant	Rice Specialist, Bihar and Orissa.	
	Berhampur Rice Research Sub-station	33	Superintendent in Madras Agricultural Service.		
Sind	Government Fruit Farm, Mirpurkhas	60	Horticulturist in Sind	Director of Agriculture, Sind, Karachi.	
	Fruit Sub-station, Larkana	60	Manager, Fruit Sub-station, Larkana.	Horticulturist in Sind, Mirpurkhas.	
	Agricultural Research Station, Sakrand.	368	Officer in charge, Agricultural Research Station, Sakrand.	Director of Agriculture, Sind, Karachi.	
	Rice Research Station, Larkana	57	Superintendent, Rice Research Station.	Botanist, Agricultural Research Station, Sakrand.	
	Jamesabad Sub-station	30	District Agricultural Overseer, Jamesabad.	Deputy Director of Agriculture, Left Bank, Hyderabad.	
	Nawabshah Sub-station	16	Inspector of Agriculture, Nawabshah.	Ditto.	
	Government Auxiliary Farm, Oderolal	362	Manager, Government Auxiliary Farm, Oderolal.	Ditto.	
	Government Auxiliary Farm, Lundo	458	Manager, Government Auxiliary Farm, Lundo.	Ditto.	
	Government Auxiliary Farm, Pad Idan	292	Manager, Government Auxiliary Farm, Pad Idan.	Ditto.	
	Government Seed Farm, Mirpurkhas	189	Cotton Breeder and Officer in charge, Government Seed Farm, Mirpurkhas.	Botanist, Agricultural Research Station, Sakrand.	
	Government Auxiliary Farm, Nasirabad.	311	Manager, Government Auxiliary Farm, Nasirabad.	Deputy Director of Agriculture, Right Bank, Larkana.	

British Baluchistan	Government Auxiliary Farm, Shahdadkote.	187	Manager, Government Auxiliary Farm, Shahdadkote.	Ditto.
	Government Auxiliary Farm, Dadu	585	Manager, Government Auxiliary Farm, Dadu.	Ditto.
	Fruit Experiment Station, Quetta	25	Assistant Pomologist	Agricultural Officer in Baluchistan.
	Seed Farm Usta, Sibi District	300	Agricultural Assistant	Ditto.
Hyderabad	Main Experimental Farm, Himayatsagar.	298	Farm Superintendent	Deputy Director, West Telingana.
	Main Experimental Farm, Warangal	104	Ditto	Deputy Director, East Telingana.
	Main Experimental Farm, Raichur	116	Ditto	Deputy Director, Karnatak.
	Main Experimental Farm, Parbhani	265	Ditto	Deputy Director, Godavari.
	Experimental Farm, Sangareddi	78	Ditto	Deputy Director, West Telingana.
	Experimental Farm, Rudrur	65	Ditto	Ditto.
	Cattle Breeding Farm, Himayatsagar	464	Ditto	Director of Agriculture.
	Poultry Farm, Himayatsagar	Suitable plot reserved on the Main Farm, Himayatsagar.	Fieldman	Deputy Director, West Telingana.
	Poultry Farm, Parbhani	Suitable plot reserved on the Main Farm, Parbhani.	Farm Superintendent	Deputy Director, Godavari.
Mysore	Government Experimental Farm, Hebbal.	228	Vice-Principal in charge, Agricultural School.	Deputy Director.
	Paddy Breeding Station, Neganahalli	62	Junior Assistant Botanist, Neganahalli.	Ditto.
	Kar *Ragi* Breeding Station, Hunsur	44	Junior Assistant Botanist, Hunsur.	Ditto.

List of Agricultural Stations in India in 1936-37—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks.
Mysore —*contd.*	Babbur Farm	220	Farm Manager	Director.	
	Singapur Kaval Farm	34	Senior Assistant Botanist	Ditto.	
	Jeevanarayanakatte Demonstration Farm.	1	Agricultural Inspector, Mysore.	Assistant Director.	
	Experimental Farm, Marthur	116	Farm Manager	Senior Assistant Director, Shimoga.	
	Government Coffee Experiment Station, Balehonnur.	290	Manager	Senior Assistant Director, Chikmagalur.	
	Irwin Canal Farm, Mandya	650	Superintendent	Director.	
	District Board Agricultural School, Hassan.	10	Head master	President, District Board, Hassan.	
	Cattle Breeding Station and Cattle Breeding Sub-station, Ajjampur.	6,020	Manager, Cattle Breeding Station.	Live-stock Expert.	
	Yellachihalli Sheep Farm	500	Agricultural Inspector in charge.	Ditto.	
	S. K. V. D. Patasala Farm	40	Head master of the School	Assistant Director, Tumkur.	
	Ramakrishna Krishisala Farm	273	Ditto	Assistant Director, Bangalore.	
Baroda	Baroda Agricultural Experimental Station.	104	R. S. Patil	Commissioner of Agriculture.	
	Jogudan Agricultural Experimental Station.	38	U. B. Bhatt		
	Amreli Agricultural Experimental Station.	63	D. G. Kelkar		
	Vyara Agricultural Experimental Station.	16	G. G. Navathe		
	Verma Agricultural Experimental Station.	63	S. B. Patel		

Travancore	Paddy Farm, Nagercoil	40	Agricultural Inspector	Director of Agriculture and Fisheries.	
	Fruit Farm, Cape Comorin	16	Agricultural Sub-Inspector		
	Agricultural School Farm, Kottarakara	200	Head master, Agricultural School.		
	Pepper Farm, Koni	150	Agricultural Inspector	Agricultural Inspector, Kottarakara.	
	Demonstration Farm, Puliyara	35	Ditto		
	Coconut Farm, Oachira	4	Agricultural Demonstrator	Agricultural Inspector, Mavelikara.	
	Coconut Farm, Alleppey	9	Ditto	Agricultural Inspector, Vaikom.	
	Kari Experimental Station, Porakad	25	Field Assistant	Bio-Chemist, Quilon	Only 5 acres are being cultivated.
	Demonstration Farm, Alwaye	13	Agricultural Sub-Inspector	Director of Agriculture and Fisheries.	
Cochin	Government Central Farm, Ollukkara, Trichur.	405	Manager, Government Central Farm.	Director of Agriculture, Cochin.	
	Government Coconut Experimental Station, Vaittila, Ernaculam.	25	Agricultural Inspector, Cochin Kanayanur Taluk.		
Bhopal	Research Farm, Nabi Bagh	154	V. N. Verma, Incharge Farm.	Director of Agriculture and State Chemist.	
	Model Farm, Semri	250	B. V. Shirali		
	Sugarcane Farm, Sehore	50	K. M. Gururaja Rao		
Gwalior	Central Experimental Farm, Gwalior	265	Manager	Deputy Director of Agriculture, Gwalior Division.	
	Central Experimental Farm, Ujjain	760	Ditto	Deputy Director of Agriculture, Malwa Division.	
Jammu and Kashmir	Pratap Model Farm	75	Ditto	Director of Agriculture.	
	Gol Samandar Farm	28	Assistant Director of Agriculture.		

List of Agricultural Stations in India in 1936-37—concld.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Burma	Hmawbi	454	Farm Superintendent	Rice Research Officer, Burma, Rangoon.	
	Mandalay	745	Ditto	Assistant Director of Agriculture in charge of College Farm, Mandalay.	
	Kanbalu	534	Ditto	Deputy Director of Agriculture, Northern Circle, Mandalay.	
	Mahlaing	243	Ditto	Deputy Director of Agriculture, Myingyan Circle, Meiktila.	
	Pyinmana	55	Ditto	Deputy Director of Agriculture, East Central Circle, Pyinmana.	
	Tatkon	107	Ditto		
	Allanmyo	143	Ditto	Deputy Director of Agriculture, West Central Circle, Magwe.	
	Sa-aing	12	Ditto		
	Myaungmya	92	Ditto	Deputy Director of Agriculture, Irrawaddy Circle, Bassein.	
	Mudon	140	Ditto	Deputy Director of Agriculture, Tenasserim Circle, Moulmein.	
	Akyab	49	Ditto	Deputy Director of Agriculture, Arakan Circle, Akyab.	
	Kyaukpyu	23	Ditto		
	Paukkaung	16	Ditto	Entomologist, Mandalay.	

APPENDIX II (*b*)

List of Agricultural and Veterinary Stations in India (classified)

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			IMPERIAL AGRICULTURAL DEPARTMENT			
1. New Delhi	1. Coimbatore (Madras) (Sugarcane Breeding Station) 2. Karnal (Agriculture and Sugarcane Sub-stations) (Punjab) 3. Pusa (Bihar) (Botanical Sub-station) 4. Simla (Punjab) (Potato Breeding Sub-station) 5. Guntur (Madras) (Tobacco Breeding Sub-station)				1. New Delhi 2. Karnal (Punjab)	
			IMPERIAL DAIRY DEPARTMENT			
1. Bangalore	1. Anand (Research Creamery)				Bangalore	Wellington (Nilgiris)
			IMPERIAL VETERINARY DEPARTMENT			
1. Mukteswar (U. P.)	1. Izatnagar (U. P.)					

List of Agricultural and Veterinary Stations in India (classified)—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			MADRAS			
			Agricultural Department			
1. Coimbatore	1. Anakapalle		1. Kalahasti		1. Hosur	1. Guntur
	2. Samalkota					
	3. Maruteru					
	4. Guntur					
	5. Nandyal					
	6. Hagari					
	7. Anantarajupet					
	8. Gudiyatham					
	9. Tindivanam					
	10. Palur					
	11. Aduturai					
	12. Pattukottai					
	13. Koilpatti					
	14. Burliar					
	15. Coonoor					
	16. Kallar					
	17. Nanjanad					
	18. Pattambi					
	19. Taliparamba					
	20. Kasargod					
	21. Pillicode					
	22. Nileshwar					

2. Madras: (Veterinary College)	23. Buchireddipalam 24. Ambasamudram		*Veterinary Department*			
			BOMBAY			
			Agricultural Department			
1. Poona	1. Surat 2. Nadiad 3. Dhulia 4. Dharwar 5. Karjat 6. Padegaon 7. Sholapur (Dry Farming Research Station) 8. Bijapur (Dry Farming Research Sub-station)	1. Ratnagiri 2. Dhulia 3. Jalgaon 4. Surat 5. Kirkee (Ganeshkhind Fruit Experimental Station) 6. Kirkee (Central Poultry Farm)	1. Kumta 2. Mugad 3. Gokak Canal 4. Hathkhamba 5. Mohol 6. Kopargaon 7. Broach 8. Dohad 9. Viramgaon 10. Kundewadi, Niphad (Wheat Breeding Station)	1. Bhadgaon	1. Chharodi 2. Bankapur 3. Kirkee (Agricultural College Dairy)	1. Tegur 2. Surat
2. Bombay: (Veterinary College)			*Veterinary Department*			

List of Agricultural and Veterinary Stations in India (classified)—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			BENGAL			
			Agricultural Department			
1. Dacca	1. Berhampore	1. Dacca	1. Burdwan		1. Dacca	
	2. Rangpur	2. Chinsurah	2. Berhampore			
	3. Krishnagar	3. Rajshahi	3. Bankura			
	4. Chinsurah		4. Suri			
	5. Bankura		5. Krishnagar			
	6. Rangamati		6. Jessore			
	7. Kalimpong		7. Gosaba			
			8. Fatidpur			
			9. Rangamati			
			10. Comilla			
			11. Barisal			
			12. Kishoreganj			
			13. Mymensingh			
			14. Pabna			
			15. Dhanbari			
			16. Bogra			
			17. Jamalpur			
			18. Rangpur			
			19. Malda			
			20. Dinajpur			
			21. Mainaguri			
			22. Charbadna			

2. Calcutta : (Bengal Veterinary College)			*Veterinary Department*		
			UNITED PROVINCES		
			Agricultural Department		
1. Cawnpore (Agricultural College)	1. Shahjahanpore	1. Gorakhpur	1. Benares	1. Muttra	
2. Bulandshahr (Agricultural School)	2. Raya-Muttra	2. Partabgarh	2. Fyzabad	2. Kheri	
3. Gorakhpur (Agricultural School)	3. Cawnpore	3. Muzaffarnagar	3. Etawah	3. Bharari	
	4. Nagina	4. Jeolikote	4. Mainpuri	4. Hempur	
			5. Bichpuri		
			6. Hardoi		
			7. Baharaich		
			8. Bulandshahr		
			9. Nigohi		
			10. Budaun		
			11. Nawabganj		
			12. Meerut		
			13. Attara		
			14. Hydergarh (Bara Banki)		
			15. Bara Banki		
			16. Unao		
			17. Kalianpur (Cawnpore)		
			18. Kalai (Aligarh)		
			19. Tarikhot		
			20. Beh Pal (Hamirpur)		
			21. Turnot (Rae Bareli)		

List of Agricultural and Veterinary Stations in India (classified)—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			PUNJAB			
			Agricultural Department			
1. Lyallpur	1. Risalewala	1. Lyallpur	1. Gurgaon	1. Fatna		
	2. Sirsa (Botanical Sub-station)	2. Montgomery	2. Karnal	2. Shergarh		
	3. Rohtak (Dry Farming Research Station)	3. Hansi	3. Ambala	3. Vihari		
	4. Jullundur (Sugarcane Research Station)	4. Multan	4. Ludhiana	4. Risalewala		
		5. Jullundur	5. Beas	5. Chillianwala		
		6. Gurdaspur	6. Kangra	6. Sargodha		
		7. Kala Shah Kaku	7. Ferozepur	7. Multan		
		8. Rawalpindi	8. Gujranwala	8. Yusufwala		
			9. Gujrat			
			10. Jhang			
			11. Mianwali			
			12. Campbellpur			
			13. Attari			
			Veterinary Department			
2. Lahore: (Punjab Veterinary College)					1. Hissar	1. Jahangirabad Farm.
						2. Allahdad Farm
						3. Bahadurnagar Farm
						4. Qadirabad Farm
						5. Montgomery Dairy Farm

1. Mandalay		BURMA *Agricultural Department*	1. Chiba 2. Kyehmon 3. Singaing 4. Pwinbyu 5. Magwe 6. Pyu 7. Paungde 8. Homzadu 9. Pegu 10. Kaubin 11. Thatoh 12. Padu 13. Nyaungleebin 14. Pyapon 15. Bassein 16. Thegan-Gwasoh 17. Minbya 18. Mingan 19. Myingyan 20. Zigon 21. Ye-U	1. Taikon	6. Shergarh Small Holders' Grant
	1. Maubgmya 2. Hmawbi 3. Mudon 4. Akyab 5. Alhalmyo 6. Pyinmana 7. Mahlaing 8. Kanbalu				
2. Insein: (Veterinary College)		*Veterinary Department*			

A List of Agricultural and Veterinary Stations in India (classified)—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			BIHAR			
			Agricultural Department			
1. Sabour	1. Muzaffarpur (Sugarcane Research Station)	1. Kanke	1. Purulia		1. Kanke	
			2. Gaya		2. Sepaya	
	2. Sabour (Rice Research Station)	2. Patna	3. Neterhat			
	3. Sabour (Horticultural Research Station)	3. Sepaya	4. Nawadah			
			5. Jamui			
	4. Patna (Sugarcane Research Substation)	4. Sabour	6. Banka			
			7. Darbhanga			
	5. Kanke (Rice Research Substation)		8. Siwan			
			9. Bikramgunj			
	6. Gaya (Rice Research Substation)		10. Siris			
			11. Chianki			
			12. Chaibasa			
			Veterinary Department			
2. Patna: (Bihar Veterinary College)					3. Phulwari	
			CENTRAL PROVINCES AND BERAR			
			Agricultural Department			
1. Nagpur	1. Akola	1. Powarkhera	1. Chindwara	1. Saugor	1. Ellichpur	1. Richai
	2. Raipur	2. Adhartal	2. Tharsa	2. Bilaspur	2. Powarkhera	2. Nagpur (Cattle Dairy Farm)
		3. Nagpur		3. Chandkhuri	3. Ratona	

				4. Drug 5. Seoni 6. Betul 7. Khandwa 8. Wara-Seoni 9. Yeotmal 10. Buldana 11. Bergaon 12. Sindewahi 13. Dindori	
			Veterinary Department	1. Telinkeri 2. Raigarh (Garhi) 3. Pendra 4. Bod	
			ASSAM		
			Agricultural Department		
	1. Jorhat 2. Habiganj	1. Karimganj 2. Tikabor 3. Jorhat	1. Haflong (North Cachar Hills)	1. Khanapara 2. Sylhet 3. Upper Shillong	1. Jorhat
			NORTH-WEST FRONTIER PROVINCE		
			Agricultural Department		
1. Peshawar		1. Tarnab 2. Naurang Serai	1. Haripur 2. Parachinar 3. Derah Ismail Khan		

List of Agricultural and Veterinary Stations in India (classified)—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			ORISSA			
			Agricultural Department			
	1. Cuttack Rice Research Station	1. Cuttack	1. Sambalpur		1. Cuttack	
	2. Berhampore (Rice Research Sub-station)		2. Angul			
			3. Balia			
			4. Kujang			
			5. Khurdah			
			6. Puri			
			SIND			
			Agricultural Department			
1. Sakrand	1. Larkana	1. Mirpurkhas	1. Dadu	1. Mirpurkhas		
2. Dokri	2. Mirpurkhas		2. Oderolal			
	3. Shikarpur		3. Lundo			
			4. Padidam			
			5. Nasirabad			
			6. Shahdadkote			
			7. Nawabshah			
			8. Jamesabad			
			BALUCHISTAN			
			Agricultural Department			
	1. Quetta (Fruit Experimental Station)			1. Usta		

			HYDERABAD STATE			
			Agricultural Department		1. Himayatsagar, Hyderabad (Deccan)	
1. Himayatsagar, Hyderabad (Deccan)	1. Parbhani	1. Sangareddi				
	2. Balchur	2. Warangal			2. Hingoli (Deccan)	
		3. Rudrur				
			MYSORE STATE			
			Agricultural Department			
1. Bangalore		1. Hebbal	1. Chikkanahalli	1. Mysore Irwin Canal Farm (Experimental work on sugarcane, paddy and other crops is also conducted here)	1. Ajjampur (Cattle-breeding Station)	1. Abbanaghatta
		2. Nagenahalli	2. Hassan		2. Yellachihalli (Sheep farm)	2. Basur
		3. Hunsur	3. Ramkrishnapur			
		4. Marthur	4. Singapur			
		5. Balehonnur (Headquarters of the United Planters' Association of Southern India Coffee Scientific Officer)				
		6. Babbur				
			Veterinary Department			
2. Hebbal, Bangalore (Mysore Serum Institute)						
			BARODA STATE			
	1. Baroda (Cotton Root-rot Research Scheme)	1. Baroda			1. Makarpura	
		2. Amreli				
		3. Jagudan				
		4. Vyara (Cane-farm)				

List of Agricultural and Veterinary Stations in India (classified)—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			TRAVANCORE STATE			
1. Quilon		1. Alleppey 2. Koni 3. Nagercoil	1. Alwaye 2. Oachira 3. Vaikom 4. Kottarakara 5. Puliyara 6. Cape Comorin			
			COCHIN STATE			
1. Trichur	1. Ernaculam	1. Trichur	1. Thiruvankulam 2. Trichur		1. Trichur	1. Ernaculam (Cocoanut Station) 2. Wadakkancheri 3. Mulanthuruthy
			GWALIOR STATE			
	1. Gwalior 2. Ujjain	1. Gwalior 2. Ujjain		1. Gwalior 2. Ujjain	1. Maharajpur (Gwalior) 2. Ujjain	1. Maharajpur (Gwalior) 2. Ujjain
			KASHMIR STATE			
		1. Shalabagh, Srinagar (Pratap Model Farm) 2. Jammu (Golsamandar)	Reasi Farm (Jammu Province) Rakh Manghai (Jammu Province)			

1. Nabi Bagh			**BHOPAL STATE** 1. Sehore (Cane Farm) 2. Semri (Model Farm)	1. Sehore (Cane Farm) 2. Semri		
1. Patiala Bhupindra Agricultural Institute, Rauni		1. Patiala (Bhupindra Agricultural Farm)	**PATIALA STATE** 1. Dhunda (Dt. Bassi) 2. Pharwahi (Dt. Barnala) 3. Sadharanpur (Dt. Sunam)		1. Patiala (Bhupindra Dairy Farm)	
1. Indore (Central India)	1. Sri Ganganagar (Bikaner State) 2. Basi (Jaipur) 3. Mandore (Jodhpur) 4. Alwar 5. Lake House Farm, Khetri (Jaipur) 6. Dhar 7. Kukshi (Dhar) 8. Dhamnod (Dhar) 9. Datia 10. Dosigaon Farm (Ratlam)	1. Indore	**NON-OFFICIAL** *Institute of Plant Industry* 1. Basi 2. Pali (Jodhpur) 3. Mirapurkhas Farm, Khetri (Jaipur) 4. Datia 5. Dosigaon Farm 6. Rewa			

List of Agricultural and Veterinary Stations in India (classified)—concld.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			Indian Lac Research Institute			
1. Ranchi (Bihar)						
			Indian Tea Association			
1. Tocklai (Assam)		1. Borbhetta	1. Tulsipara (Dooars)			
			United Planters' Association, South India			
1. Nellacotta (Nilgiris) Tea Experimental Station		1. Sidapur (Coorg) Coffee Experimental Farm				

APPENDIX III

Staffs of Provincial and State Departments of Agriculture in India during 1936-37

Name of Province or State	RESEARCH AND TEACHING STAFF						DISTRICT STAFF					
	SUPERIOR SERVICE		PROVINCIAL SERVICE		SUBORDINATE SERVICE		SUPERIOR SERVICE		PROVINCIAL SERVICE		SUBORDINATE SERVICE	
	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively
British India												
Madras	3	2	25	22	110	109	7	7	16	13	265	253
Bombay	2	2	18	18	108	108	3	3	8	8	112	112
Bengal	1	1	8	7	38	36	1	1	8	7	152	152
United Provinces	7	7	16	16	70	70	13	11	23	23	316*	316*
Punjab	13	12	27	27	132	132	10	9	20	19	418	418
Bihar	..	..	10	7	8	2	2	2	26	19	106	105
Central Provinces and Berar	2	2	3 (class I) 4 (class II)	2 (class I) 4 (class II)	16 4	16 4	3	3	6 (class I) 9 (class II)	3 (class I) 9 (class II)	121	121
Assam	1	1	3	3	18	18	..	..	4	4	24	24
North-West Frontier Province	..	..	3	3	19	19	..	..	..	..	15	15
Sind	2	2	5	5	17	17	..	..	3	3	103	103

* Excludes temporary staff in Canal scheme, C. D. Works, etc.

Staffs of Provincial and State Departments of Agriculture in India during 1936-37—concld.

Name of Province or State	RESEARCH AND TEACHING STAFF						DISTRICT STAFF					
	SUPERIOR SERVICE		PROVINCIAL SERVICE		SUBORDINATE SERVICE		SUPERIOR SERVICE		PROVINCIAL SERVICE		SUBORDINATE SERVICE	
	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled Substantively
Orissa	..	..	1	1	(a) 7	7	..	..	2	2	(b) 19	19
Baluchistan	1	1	..	..	10	2	..	..	..	..	..	..
Indian States												
Hyderabad	2	2	4	3	9	8	5	5	6	6	54	51
Mysore	..	..	15	15	68	68	..	..	13	13	109	109
Baroda	..	..	3	3	4	4	4	4	11	11	19	19
Travancore	8	8	..	..	4	4	11	11	..	..	14	14
Cochin	4	4	..	..	16	10	8	7	..	..	6	6
Bhopal	1	1	3	3	2	2	The same staff, as noted in the preceeding columns, works in the district and mofussils.					
Gwalior	..	6	..	..	..	..	..	41	..	..	..	..
Jammu and Kashmir	..	..	..	..	..	..	1	1	4	4	29†	23†
Burma	4	3	5	5	18	14	8	8	8	7	87	69

(a) Temporary technical posts.

(b) Includes 5 temporary posts.

† Staff under subordinate service does not include Ministerial and Menial Staff.

APPENDIX IV

Showing results of well-boring in India during 1936-37

Province or State	1935-36		1936-37	
	Number of bores	Number successful	Number of bores	Number successful
British India				
Madras	995	671	1,034	775
Bengal	206	196	314	309
United Provinces	2,126	1,736	3,065	2,637
Punjab	420	345	479	381
Bihar	..	..	189	135
Orissa	..	..	11	10
North-West Frontier Province	13	12	2	..
Sind	..	..	3	2
Indian States				
Hyderabad	35	29	35	26
Mysore	31	17	22	14
Baroda — Bores	55	42	100	57
Baroda — Blastings	33	24	98	78
Gwalior	21	21	15	10

APPENDIX V

Showing sale of improved implements through departmental agency in India during 1936-37

Province or State	Ploughs		Cane Mills		Fodder Cutters		Hoes		Other implements		Spare parts	
	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37
British India												
Madras	..	2,918	..	293	..	9	..	37	..	1,179	..	4,528
Bombay	573	535	222	27	5	4	76	42	3,160	1,778	1,605	612
Bengal	167*	224	27*	11	..	..	9	22	21*	42	2	5
United Provinces	6,479	6,454	348	355	3,575	8,319	860	1,082	1,030	599	16,499	20,601
Punjab	5,892	6,806	2,081	2,396	28,768	36,057	596	1,160	3,406	7,253	7,985	11,897
Bihar	..	2,172	..	26	..	4	..	154	..	58	..	550
Central Provinces and Berar	2,262	2,753	178	229	20	9	681	427	1,688	1,432	21,216	23,019
Assam	3	2	72	109	..	..	..	3	74	71	108	153
North-West Frontier Province	89	57	193	198	29	41	15	3	116	12	97	11
Orissa	..	2	..	3	..	1	..	4	..	9	..	..
Sind	1,254*	783	..	..	..	..	12*	..	†232*	188‡	513*	33
Burma	8,405	13,652	10	19	..	2	650	1,115	895	856	133	303

| Indian States | | |

APPENDIX VI

Improved seeds and manures distributed through departmental agency in India during 1936-37

Province or State	SEED DISTRIBUTED						MANURES DISTRIBUTED			
	SEED GRAIN IN CWT.		NO. OF WHOLE CANES EXCEPT WHERE OTHERWISE STATED		FRUIT PLANTS NO.		COMMERCIAL FERTILIZERS IN CWT.		OIL CAKES IN CWT.	
	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37
British India										
Madras	..	16,546	..	159,769	..	142,850	..	..	..	..
Bombay	38,714	34,738	1,920,442	3,390,359	108,490*	248,827	26,139	21,097	7,206	10,413
Bengal	7,114*	8,322	(a) 13,964,322*	(b) 6,028,420*	16,089*	17,118	2,153*	3,281	168*	2,371
United Provinces	187,222	229,753	2,652,111	2,054,798	11,768	10,694	79,415	59,911	16,982	9,388
Punjab	163,889	229,914	(c)	(c)	6,700	20,900	(d)	(d)	..	..
Bihar	..	6,746	..	24,415	..	..	..	1,422	..	2,381
Central Provinces and Berar	269,741	308,335	3,705,066	(Cwts.) 4,248,761	(e)65,303	78,069	9,300	7,248	577	1,138
Assam	2,105	1,225	(a) 303,761	(a) 480,175	34,711	21,043	127	48	78	2
North-West Frontier Province	5,151	7,772	100† / 299‡	2,700† / 135‡	21,988*	10,044	134	239	..	..

Orissa	..	3,619	..	90,300	..	3,698	..	37	..	7
Sind	36,900*	72,810	(Mds.) 1,055	(Mds.) 770	(Mds.) 32,108	(Mds.) 27,660	1	6	..	..
Baluchistan	492	192	..	..	1,573	2,000	..	..	..	..
Burma	138,535	159,545	1,478,300(a)	3,292,800(a)	12,687	18,734	3,760	8,317	..	..

Indian States

Hyderabad	5,087	12,125	11,787 (Cwts.)	770 (Cwts.)	1,607	4,553	5,500	2,423	10,348	144
Mysore	15,703	4,819	2,858,790	23,084,437 (a) 761,700	6,143	1,671	94,732	1,146	4,005	..
Baroda	178*	409	(a) 40,935 *plus* 16,440 lbs.	(a) 61,452 *plus* 17,109 lbs.	2,853*	3,802	38*	7	..	10
Travancore	(f) 167	(f) 163	(a) 19,200	(a) 21,350	1,231	1,304	No direct sales by the Department.			
Cochin	324*	361	3,165*	2,155	15,693*	23,019	116*	364	140*	268
Bhopal	522	700	1,600	2,000	200	250	10	300	3	10
Jammu and Kashmir	710	1,078	(g)412	21,500	170,690	177,719	6	4	..	..
Gwalior	2,966	7,430	1,068,800	1,939,141	13,418	16,896	141	222	23	40

* Revised.
† Whole canes.
‡ Cwts.
(a) Setts.
(b) Cane cuttings.
(c) The Department does not stock sugarcane seed for sale apart from such areas as are available from its seed farms.
(d) Artificial manures are supplied to zamindars directly by manufacturers and no record of their sale is available with the Department of Agriculture, Punjab.
(e) Figs. for southern circle not available.
(f) Paddy.
(g) *Gandharas.*

APPENDIX VII

Demonstration and propaganda work in India during 1936-37

Province or State	Number of Agricultural Shows held		Number of practical demonstrations carried out		Number of illustrated lectures given	
	1935-36	1936-37	1935-36	1936-37	1935-36	1936-37
British India						
Madras	..	470	..	25,407	..	649
Bombay	76	53	2,300	2,714	605	1,107
Bengal	74*	56	4,613*	6,243	221*	347
United Provinces	162	198	12,642	19,840	5,317	1,650
Punjab	365	432	12,327	13,824	1,224	702
Bihar	..	25	..	22,333	..	..
Central Provinces and Berar	107	101	8,053	8,987	623	443
Assam	19	7	2,170	1,754	46	17
North-West Frontier Province	5	5	1,169	1,497	231	786
Orissa	..	8	..	5,164	..	75
Sind	48*	54	636*	691	81*	58
Baluchistan	1	2	†	‡	..	§
Burma	5	36	3,201	4,106	160	100

Indian States								
Hyderabad	50	60	452	573	107		154	
Mysore	221	402	2,404	2,371	534		304	
Baroda	6*	7	8*	401	57*		270	
Travancore	5	7	208	217	42		50	
Cochin	4	3	275*	343	16*		24	
Bhopal	6	8	57	..	15		20	
Jammu and Kashmir	1	3	129¶ (a) 209‖	144¶ (b) 300‖	32		60	
Gwalior	9	4	721	389	..		..	

* Revised figures.
† Insecticidal spraying demonstrations carried out throughout the province.
‡ Ditto; 'Tid' control demonstration in Usta Colony. Rat killing demonstrations carried out throughout the province.
§ A discourse on 'Tid' control at Usta show.
¶ Practical Demonstrations of pruning, budding and planting of fruit trees.
‖ Manurial Demonstrations.
(a) 529,120 fruit plants and 6,758 roses were sprayed at owners' cost in the valley. Free Government machinery and technical labour.
(b) 581,876 plants and 5,412 ornamental plants were sprayed at owners' cost in the valley. Free Government machinery and technical labour.

APPENDIX VIII

Agricultural Colleges and Schools in India during 1936-37

Name of college or school	Course of instruction	1935-36				1936-37			
		Applications for admission	Admissions made during the year	Total No. on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total No. on the roll	Number passed in final examination
BRITISH INDIA									
Agricultural Colleges									
Imperial Agricultural Research Institute, New Delhi.	Two-year post-graduate course.	33	10	(a) 25	7	68	13	(a) 30	9
	One-year post-graduate course in farm management.		3	6	3		3	6	3
	Special short course in flue-curing of tobacco.	..	4	4	4	..	4	4	4
Imperial Dairy Institute, Bangalore.	Fifteen-month post-graduate course.	..	2	1	1	6	5	5	5
	Indian Dairy Diploma course (2 years).	65	24	23	17	No fresh admissions as this is intervening year.	(b) 4	(c) 23+4	..
	Short course . .	10	8	10	8	32	11	11	(d) 10
	Vocational training of British soldiers (6 months).	25	25	25	(e) 13	15	15	15	(f) 15
Agricultural College, Coimbatore	B.Sc.Ag. degree course of the Madras University.	116	(g) 46	110	28	156	(h) 47	108	28
Agricultural College, Poona .	Three-year degree course .	114	81 (i)	170	43	138	78 (j)	166	42 *plus* 1 M. Sc.
Agricultural College, Cawnpore .	B. Sc. Agri. . . .	129	54	160	74	131	56	155	70

Allahabad Agricultural Institute	Indian Dairy Diploma Course	45	31	62	28	..	29	69	27
	Intermediate in Agriculture .	27	21	32	16	25	23	41	18
	B. Sc. in Agriculture . .	..	..	8	..	52	31	40	6
Punjab Agricultural College, Lyallpur.	(1) Four-year B.Sc. Degree course.	180*	68	186	15†	180	68	208	24 (including 3 compartment students of the last year.)
	(2) 1½-year M. Sc. Degree course.	3	1	4	..	3	3	3	1
	(3) 2-year Leaving Certificate course.	..	..	9	8	..	..	16	15
	(4) Six months' summer vernacular course at Lyallpur.	‡	42	39	35	See item 9 below.		..	..
	(5) Six months' summer vernacular course at Gurdaspur.	43	20	20	17	82‡	30	20	29
	(6) Six months' winter vernacular course at Lyallpur.	‡	30	28	25	See item 9 below.		..	..
	(7) Six months' winter vernacular course at Gurdaspur.	57	42	38	37	77‡	29	27	27§
	(8) Ten months' Teachers' Training course.	122	30	30	30	52	32	32	24
	(9) One-year vernacular class.	..	..	..	..	‖	52	43	30‖

(*a*) One left without completing the course.
(*b*) Repeat course students.
(*c*) To be examined in November 1937.
(*d*) One completes in August 1937.
(*e*) 12 passed in August 1936.
(*f*) 12 soldiers out of 15 admitted in 1936-37 to complete in September 1937. This includes 12 of (*e*).
(*g*) Includes two students who resigned subsequently.
(*h*) Includes two who stopped away during the third term.
(*i*) 101 admitted but only 81 finally remained on the roll.
(*j*) 104 students were actually admitted in June but the position was changed in July and 78 students remained permanently.
* Total number of applications received for admission to Leaving Certificate and Degree courses.
† 9 students under compartment excluded.
‡ Applications for admission were received by respective Deputy Directors of Agriculture.
§ Besides two failed students of the previous class (1935-36) appeared in the examination and got through.
‖ Number who qualified from the winter vernacular class admitted on 1st October 1936.

Agricultural Colleges and Schools in India during 1936-37—contd.

Name of college or school	Course of instruction	1935-36				1936-37			
		Applications for admission.	Admissions made during the year	Total No. on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total No. on the roll	Number passed in final examination
Agricultural Colleges—*contd.*									
Punjab Agricultural College, Lyallpur—*contd.*	(10) Six months' vernacular course in Dairying.	20	11	11	10	20	10	6	6
	(11) Two months' Bee-keeping class at Nagrota.	..	..	..	..	21	12	8	8
	(12) Six weeks' course in *Lohar* class.	30	30	14	12	18	16	16	15
	(13) Seven months' advanced course in Fruit and Vegetable preservation.	..	..	..	..	..	7	6	6
	(14) Two weeks' summer course in Fruit and Vegetable preservation.	131	42	32	32	105	29	28	28
	(15) Two weeks' Fruit culture course.	57	32	29	24	27	18	17	17
	(16) Two weeks' winter Fruit preservation course.	38	29	16	16	23	21	21	21
	(17) One-year *Mali* class	..	..	..	..	287	35	30	30
	(18) Three months' Bee-keeping class at Raison (Kulu).	..	..	..	..	13	10	10	10
Agricultural College, Nagpur	Four-year Degree course	89	48	135	20	157	58	151	15

Agricultural Schools

Madras.										
School for juveniles at Coimbatore.	3 R's, I and II standards .	..	24	* 19	9	40	40	27	6
School for juveniles at Palur .	3 R's, I to V standards .	5	5	29	1	12	12	31	3
School for juveniles at Anakapalli.	3 R's, I to V standards .	50	9	24	17	19	19	24	14
Bombay.									
Vernacular Agricultural School, Dhulia.	Two-year course . . .	60	17	32	14	50	15	30	15
Vernacular Agricultural School, Devihosur.	Two years' course in vernacular (Kanarese).	37	15	32	16	35	20	30	8
Bengal.									
Dacca Secondary Agricultural School.	Two years' course . .	397*	20	36	13	410	20	42	14
Bhutnath Paul Agricultural School, Chinsurah, Hoogly.	Ditto . . .	25	14	9	6	35	17	19	9
United Provinces.									
Agricultural School, Bulandshahr.	2 years' course . . .	25	25	25	25	101	25	21	21
	Fieldman class . . .	6	6	6	6	35	14	14	14
	Farm Mech. class . .	18	8	8	8	31	15	15	13
Agricultural School, Gorakhpur	2 years' course . . .	66	27	25	20	116	43	36	25
Central Provinces.									
Agricultural Anglo-vernacular Middle School, Powarkhera, Hoshangabad.	Four-year course . . .	18	18	68	9	36	36	35	12

INDIAN STATES

Cochin.									
Horticultural Schools—									
1. Central Farm . . .	Two-year . . .	60	60	60	45	60	60	60	48
2. Trichur									
3. Tripunithura . .									

* Revised figures.

Agricultural Colleges and Schools in India during 1936-37—concld.

Name of college or school	Course of instruction	1935-36				1936-37			
		Applications for admission	Admissions made during the year	Total No. on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total No. on the roll	Number passed in final examination
Baroda.									
Sheth Dosabhai Maganlal Agricultural Institute, Baroda State, Baroda.	(Agricultural) one-year course	81	25	23	23	100	25	24	24
Hyderabad.									
Oil Engine Class, Machinery Section.	3 months	31	26	24	20	28	19	19	14
Gardeners' Class, Himayatsagar Main Farm.	2 years . . .	15	7	10	2	4	4	9	4
Farmers' Class, Himayatsagar Main Farm.	Ditto	41	12	11	..	41	12	22	11
Farmers' Class, Parbhani Main Farm.	Ditto	28	12	11	..	36	12	23	10
Farmers Class, Rudrur Experimental Farm.*	Ditto	..	..	..	..	10	6	6	..
Mysore.									
Agricultural School, Hebbal .	3 years . . .	54	37	92	31	38	37	74	20
Ramakrishna Krishisala, Anekal Taluk.	1 year	45	16	15	14	64	16	15	15

S. K. V. D. Patasala, Chikkanahalli.†	1 year	57	18	18	16	89	18	18	18
District Board vernacular Agricultural School, Hassan.	Ditto	74	21	20	10	64	23	22	22
Travancore.									
Agricultural School, Kottarakara	Two-years	50	20	18	13	*Nil*	..	17	15
Agricultural School, Koni . .	Ditto	..	30	24	No examination.	75	30	30	15
Jammu and Kashmir.									
Agricultural Training Class .	One-year vernacular course. General Instructions in Agriculture, Horticulture, Entomology, Veterinary Science and other allied subjects.	*Nil*	*Nil*	*Nil*	*Nil*	35	15	15	Examination not held yet.
Burma.									
Pyinmana Agricultural School .	Four years' course .	..	34	72	12	..	31	74	23
Farm School—									
(*a*) Hmawbi . . .	Nine months' course . .	..	10	8	7	..	12	10	8
(*b*) Mahlaing . . .	Ditto . . .	..	4	13	13	..	15	11	11
Training of adult Cultivators .	Short courses . . .	..	33	33	32	..	30	35	30

* Started this year.

† The classes are run just on the lines of the previous 6-monthly and now one-year vernacular class of the Punjab Agricultural College, Lyallpur. Students are provided with free lodging, and a stipend of Rs. 8 is paid to each student per month, for the whole year.

APPENDIX IX

Operations of Non-credit Agricultural Co-operative Societies in India during 1936-37

(A) Purchase, Sale and Production

Province or State	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working capital	Profit and loss (—) for the year
				Rs.	Rs.	Rs.	Rs.
Madras	Purchase and purchase and sale	126	13,799	5,07,268	4,83,612	20,02,069	25,273
	Production and sale	24	1,397	38,857	36,299	1,39,227	—6,002
	Others	351	22,586	39,957	3,08,899	30,35,923	—4,14,881
	Total	501	37,782	5,86,082	8,28,810	51,77,219	—3,95,610
Bombay	Purchase and purchase and sale	68	7,946	23,345	1,93,960	2,50,766	8,332
	Production	17	625	..	..	9,085	—54
	Production and sale	84	17,634	5,52,090	17,298	16,00,879	67,839
	Others	135	40,402	90,702	13,785	5,86,284	17,533
	Total	304	66,607	6,66,137	2,25,043	24,47,014	93,650

Bengal	Purchase and purchase and sale	67	13,297	3,71,886	2,09,075	7,52,541	15,921
	Production	975	22,091	..	..	5,02,745	—7,515
	Production and sale	246	14,212	1,90,199	2,64,647	9,99,814	75,544
	Others	39	9,627	790	29	1,70,086	—9,486
	TOTAL	1,327	59,227	5,62,875	4,73,751	24,25,186	74,464
United Provinces	Purchase and sale	5	1,303	262	..	5,999	39
	Production and sale	710	48,837	8,87,876	9,16,354	3,45,648	69,914
	TOTAL	715	50,140	8,88,138	9,16,354	3,51,647	69,953
Punjab	Purchase and purchase and sale	18	1,482	93,341	85,236	75,916	2,822
	Production	255	5,846	..	..	7,769	640
	Production and sale	1,481	129,115	7,20,016	16,05,557	6,23,841	—9,589
	Others	98	2,025	..	..	99,408	3,788
	TOTAL	1,852	138,468	8,13,357	16,90,793	8,06,934	—2,339
Bihar	Purchase and purchase and sale	4	215	9,443	9,571	2,700	80
	Production and sale	124	1,866	9,443	11,477	14,113	—265
	TOTAL	128	2,081	18,886	21,048	16,813	—185

Operations of Non-credit Agricultural Co-operative Societies in India during 1936-37—contd.

(A) PURCHASE, SALE AND PRODUCTION—*contd.*

Province or State	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working capital.	Profit and loss (—). for the year
				Rs.	Rs.	Rs.	Rs.
Central Provinces and Berar	Purchase and sale	47	2,120	1,07,551	76,429	3,47,619	13,413
	Production	15	368	1,030	..	8,056	985
	Production and sale	10	849	8,221	8,719	24,079	843
	TOTAL	72	3,337	1,16,802	85,148	3,79,754	15,241
Assam	Production	1	206	..	..	3,511	—4
	Production and sale	22	384	16,951	15,888	10,389	668
	TOTAL	23	590	16,951	15,888	13,900	664
N.-W. F. Province	Production and sale	25	6,870	49	..	233	11

Orissa	Purchase and purchase and sale	9	5,428	30,571	27,876	62,774	2,851
Delhi	Production	2	63	..	..	70	16
	Production and sale	18	1,223	..	..	345	73
	TOTAL	20	1,286	..	..	415	89
Hyderabad	Purchase and sale	107	2,592	1,25,144	1,22,906	2,95,662	3,373
	Sale and production	17	1,878	2,60,807	2,44,399	1,10,587	6,633
	TOTAL	124	4,470	3,85,951	3,67,305	4,06,249	10,006
Mysore	Purchase and purchase and sale	22	624	3,034	3,020	74,826	—286
	Production and sale	19	591	12,285	2,067	18,188	1,072
	Others	39	1,122	..	..	7,700	111
	TOTAL	80	2,337	15,319	5,087	1,00,714	897

Operations of Non-credit Agricultural Co-operative Societies in India during 1936-37—concld.

(A) PURCHASE, SALE AND PRODUCTION—*concld.*

Province or State	Class of societies	Number of societies.	Number of members	Sale of goods to members	Purchase of members' products	Working capital.	Profit and loss (—) for the year
				Rs.	Rs.	Rs.	Rs.
Baroda	Purchase and sale	10	405	62	52	3,146	4
	Production	29	1,199	9,071	1,811	2,11,527	10,743
	Production and sale	22	1,469	1,09,252	4,57,028	1,78,222	833
	Others	96	5,957	..	10	7,790	—1,270
	TOTAL	157	9,030	4,18,385	4,58,901	4,00,685	10,310
Travancore	Purchase and purchase and sale	1	40	1,230	2,271	1,647	20
	Production	1	44	..	..	190	13
	Production and sale	7	1,152	13,256	13,353	76,656	—507
	TOTAL	9	1,236	14,486	15,624	78,493	—474

Cochin	Purchase and purchase and sale	2	17	108	70	980	50
Burma	Purchase, purchase and sale	1	300	..	..	31,094	126
	Production and sale	10	948	2,997	..	1,07,272	—47,643
	TOTAL	11	1,248	2,997	..	1,38,366	—47,517

(B) CATTLE INSURANCE

Province or State	Number of societies	Amount of risk insured	Premia collected during the year	Supplementary contributions collected	Number of Animals		Claims paid	Cost of management	Funds in hand at the end of the year	Amount of risk re-insured	Amount of premia paid for re-insurance
					Insured	Lost					
		Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.	Rs.
Bombay	1	1,420	107	..	40	11	390	237	260	..	..
Burma	219	1,485	22	..	54	3	82	19	15,793	743	11

APPENDIX X

Working of the Veterinary Departments in India during 1936-37

Province or State	Reported mortality from contagious diseases			Dispensaries and Hospitals			District work					
	Rinderpest	Other diseases	Total	Number of Institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths uninoculated	Inoculations	Deaths after inoculation
Madras	5,102	28,151	33,253	112	262,774	24,632	137,454	48,230	1,820	16,436	489,103	479
Bombay	20,725	13,817	34,542	112	226,058	32,539	45,682	9,898	1,542	19,649	295,335	879
Bengal	26,126	23,668	49,794	56	103,475	989	122,095	10,002	1,399	27,752	376,571	5,423
United Provinces	20,901	17,450	38,351	182	546,572	84,079	81,837	15,492	2,283	25,445	377,600	283
Punjab	8,285	22,778	31,063	300	968,175	355,415	556,403	271,789	4,315	18,795	87,084	863
Burma	31,071	5,462	36,533	1	1,573	4	45,164	35	1,083	14,959	397,816	1,728
Bihar	7,918	11,178	19,096	124	97,225	20,875	241,509	90,563	858	4,689	504,415	408
Central Provinces and Berar	8,608	8,101	16,709	104	238,330	24,367	558,381	143,152	1,142	5,605	756,517	..
Assam	22,019	11,067	33,086	3	6,094	499	120,610	28,229	752	14,277	120,207	1,386
North-West Frontier Province	152	2,171	2,323	72	235,729	44,136	116,252	33,351	144	1,150	84,181	9
Orissa	2,661	1,221	3,882	8	60,437	2,402	76,724	19,708	142	2,048	138,336	122
Sind	5,532	5,585	11,117	19	31,504	2,969	17,525	1,152	106	2,555	14,024	18
Baluchistan	33	6,721	6,754	10	38,040	361	64,348	122	..	949	5,311	3
Ajmer-Merwara	686	964	1,650	3	7,192	550	2,355	74	45	500	6,422	8
Coorg	83	383	466	5	50,790	486	3,086	1,224	127	374	4,664	11
Total for British India	159,902	158,717	318,619	1,111	3,873,968	594,303	2,189,425	673,021	15,758	155,183	4,441,349	11,620
Mysore	1,078	13,014	14,092	72	472,112	20,571	52,845	41,061	..	13,082	219,977	1,769
Travancore	..	125	125	21	32,777	1,439	3,598	861	..	125	269	..
Cochin	5	54	59	9	40,371	1,047	3,130	554	..	5	1,045	54
Baroda	1,318	219	1,537	34	24,716	1,177	3,763	1,316	11,818	1,537	11,818	..

APPENDIX XI

Working of the Veterinary Colleges and Schools in India during 1936-37

Veterinary College or School	Length of Course	NUMBER OF STUDENTS						EDUCATIONAL QUALIFICATIONS OF STUDENTS ADMITTED		
		ADMITTED DURING THE YEAR		Passed final examination	Failed in final examination	UNDER INSTRUCTION AT THE END OF YEAR		Intermediate and above	Matriculate or S. L. C.	Lower qualifications
		Scholarship-holders	Others			Ordinary course	Failed students			
Madras Veterinary College—										
Diploma course	3 years	(a) 4	(a) 46	21 (Dip)	10 (Dip)	(b) 86	15	32	(c) 18	..
B. V. Sc. Degree course	3 years and one term.	..	..	..	..	..	..	..	..	..
Bombay Veterinary College	3 years	10	29	12	9	86	27	2	37	..
Bengal Veterinary College	3 years.	9	65	41	22	92	51	11	51	12
Punjab Veterinary College, Lahore	4 years course.	24	51	8	3	56	5	62	13	..
Punjab Refresher course	9 months	..	3	2	(d)	1	..	3	..	..
Punjab Farrier's course	9 months	15	5	20	..	..	..	..	20	..
Punjab Dresser's course	3 months	..	36	36	..	..	..	..	36	..
Bihar Veterinary College, Patna	3 years	8	21	12	7	40	21	7	22	..

(a) Of these, twenty belong to the Diploma course and thirty to the B.V.Sc. Degree course.
(b) Includes twenty-eight Degree course students.
(c) Includes Cambridge Senior Certificate holders.
(d) One left during the course; one completed the course as a private student.

APPENDIX XII

Cattle issued from Government Farms during 1936-37

Province or State	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1936-37	Total for 1935-36
Imperial Agricultural Research Institute, New Delhi.	6	14	..	..	48	68	40
Karnal (Agricultural Sub-station).	43	11	5	19	9	87	63
Imperial Dairy Institute, Bangalore.	1	14	..	..	19	34	118
Milk Depot, Wellington .	..	1	..	..	..	1	..
Madras	50	52	1	..	8	111	..
Bombay . . .	33	17	7	8	39	104	166
Bengal	22	27	5	1	8	63	59
United Provinces . .	..	..	..	..	..	..	..
Punjab (Government Cattle Farm, Hissar).	711	53	..	..	368	1,132	946
Bihar	13	23	..	..	9	45	..
Central Provinces and Berar	281	28	..	4	23	336	169
Assam(a)	2	10	..	..	3	15	97
North-West Frontier Province.	..	..	..	..	..	..	..
Sind	34	..	..	..	..	34	11*
Baroda State, Palace Dairy, Makarpura.	..	1	..	4	17	22	12
Cochin	10	5	5	1	13	34	6
Gwalior	6	2	..	19	1	28	4 bulls.
Burma	15	18	..	..	10	43	129
Hyderabad . . .	1	..	..	..	..	1	..
Mysore	123	39	..	..	8	170	678

(a) Issue of cattle from Sylhet, Jorhat and Khanapara was stopped owing to Johne's disease there. Hence the number is very low.

* Revised figures.

APPENDIX XIII

Area cultivated in British India and the number of animals available for cultivation (1934-35 figures)

Province or State	CULTIVATED AREA IN ACRES			NUMBER OF WORK ANIMALS				Total	Number of acres per work animal
				CATTLE		BUFFALOES			
	Net area sown	Current fallows	Total	Working bullocks	Cows used for work	Working bullocks	Female buffaloes for work		
Madras	32,801,620	11,165,710	43,967,330	6,176,509	1,129,305	1,116,701	271,235	8,693,750	5·1
Bombay	32,301,971	10,717,834	43,519,805	3,742,184	279,800	203,665	109,466	4,335,115	10·0
United Provinces	35,662,051	2,910,102	38,572,153	9,971,462	..	828,304	..	10,799,766	3·6
Punjab	26,504,016	4,619,933	31,123,949	3,965,287	79,262	461,114	160,550	4,666,213	6·7
Central Provinces and Berar	24,668,067	3,988,965	28,657,032	4,202,264	76,898	483,753	21,110	4,784,025	6·0
Assam	5,988,044	1,823,513	7,811,557	1,725,619	233,693	163,718	70,556	2,243,586	3·5
North-West Frontier Province	2,199,328	578,502	2,777,830	350,765	35,119	11,424	4,365	401,673	6·9
Delhi	204,696	23,098	227,794	35,579	298	628	215	36,720	6·2
Coorg	137,421	171,919	309,340	39,566	1,359	11,003	752	52,680	5·8
Ajmer-Merwara	359,186	143,777	502,963	111,794	5	4,599	4,361	120,759	4·2
TOTAL	161,326,400	36,143,353	1,937,469,753	30,321,029	1,885,739	3,284,909	642,610	36,134,287	5·5

APPENDIX XIV (*a*)

List of Research Schemes of the Imperial Council of Agricultural Research, completed up to 31st March 1937

1. *General Agricultural Schemes*

1. Grant to Dr. K. C. Mehta for—
   (*a*) Investigation of rusts of wheats and barley.
   (*b*) Investigation into the physiologic forms of wheat rusts.
   (*c*) Giving some relief from a part of his duties at the College.
2. Appointment of a Hemp Marketing Officer.
3. Investigation into the vitamin contents of mangoes.
4. Prof. Parija's scheme of water-hyacinth.
5. Dr. A. N. Puri's scheme of standardisation of physico-chemical single value measurements most suitable for Indian soils.
6. Dr. Bhatnagar's schemes—
   (*a*) Effects of ions on plant growth.
   (*b*) Physico-chemical properties and fertility of soil.
7. Prof. Dastur's scheme of rice physiology.
8. Dr. Chaudhuri's scheme for investigations on the wither tip of citrus trees.
9. Grants to provinces for collecting data on manurial experiments conducted in the past.
10. Exhibits for world's Grain Exhibition and Conference.
11. Distribution of sodium fluo-silicate.
12. Experimental consignment of mangoes to the Empire Marketing Board.
13. Cost of exhibits in connection with commercial samples room of the High Commissioner's Office.
14. Grant to Burma Shell Oil Storage and Distributing Co., Bombay, for tractor operating costings.
15. Enquiry into supply of coconut products in India.
16. Headquarters Marketing Staff.
17. Award of a prize for a bone crusher worked by—
    (i) Animal power and
    (ii) Mechanical power.
18. Training of an officer in the gas storage of fruits and vegetables.

2. *Sugar Schemes*

1. Deputation of a Chemist to Bhopal to test Khan Bahadur Hadi's process of manufacturing sugar by open pan method.
2. Hadi's commercial test at Bilari under L. Har Sahai Gupta.
3. Bengal scheme for sugarcane crushing and *gur* boiling.
4. Deputation of Sugar Technologist to Europe and America.

5-7. Lumpsum grants to the United Provinces, Bihar and Orissa and Punjab Governments in designing a satisfactory small power sugarcane crushing mill.

8. Grant to the Sugar Section of the Harcourt Butler Technological Institute, Cawnpore.

9. Investigation into the production *khandsari* sugar in the United Provinces.
10. Bihar *Khandsari* Scheme.
11-14. Sugar Technologist—
    (*a*) Main Office.
    (*b*) Sugar Cable Service.
    (*c*) Construction and testing of improved juice-boiling *bel*.
    (*d*) Indian Sugar Trade Information Service.
15. Grant to Sugar Demonstration Section of the United Provinces Industrial and Agricultural Exhibition.
16. Deputation of Mr. P. V. Isaac to America, Porto Rico, etc., in connection with research on insect pests of sugarcane and representation at the fourth Imperial Entomological Conference.

3. *Animal Husbandry Schemes*

1. Testing of Drug Plasmoquine.
2. Appointment of a Statistician for the compilation of certain statistics relating to feeding scales, etc., in Military Dairies.
3. Investigation into the measures of control in existence for the prevention of adulteration of milk and other dairy products.
4. Training of Mr. H. C. Verma in the preparation of skimmed milk and dried milk powder.
5. Punjab Apiculture scheme regarding the training of an Agricultural Assistant in apiculture abroad.
6. All-India Legislation for the control of Animal Diseases.

APPENDIX XIV (*b*)

List of Research Schemes of the Imperial Council of Agricultural Research in operation on the 31st March 1937

1. *General Agricultural Schemes*

1. Professor Mukerjee's scheme of research into properties of colloid soil constituents.
2. Professor Mahalanobis scheme—
   (*a*) Investigation on experimental errors in field trials.
   (*b*) Statistical studies relating to agricultural work in India.
3. Grant to Principal, Agra College, for investigation into rusts of wheat and barley.
4. Establishment of a new branch of Agricultural Meteorology under the Indian Meteorological Department, Poona.
5. Appointment of a Physical Assistant on the Staff of Agricultural Chemist, Bengal.

6-12. Co-ordinated scheme of rice research in provinces.

13. Punjab locust research.
14. Research work on potatoes in Madras.
15. Financial assistance to the Oil Technological Section of Harcourt Butler Technological Institute.
16. Investigation on the organic constituents of Indian soils, by Professor J. C. Ghosh.
17. Preparation of cheap synthetic manure from town refuse and waste materials at the Indian Institute of Science, Bangalore.
18. Investigation of the chemistry of malting *cholam*.
19. Extension of work on 'quality' in crops at the Indian Institute of Science.
20. Professor J. B. Seth's scheme for investigating an electric method of hygrometry.

21-23. Scheme of malting and brewing qualities of barleys in the United Provinces, Punjab and Bihar and Orissa.

24. Systematic cultivation of medicinal plants and study of food poisons in India, by Colonel Chopra.
25. Statistical Section of the Bureau of Agricultural Intelligence.
26. Bombay cold storage fruit scheme.

27-30. Dry-farming research schemes in Bombay, Hyderabad, Madras and the Punjab.

31. Improvement of castor crop, by H. E. H. the Nizam's Government.
32. Potato breeding research in Northern India.

33-41. Tobacco co-operative experiments.

42-54. Fruit and vegetable research schemes in Madras, Bengal, Punjab, United Provinces, Bihar and Orissa, Central Provinces, Assam, North-West Frontier Province, Hyderabad and Mysore.

55. *Gangai* pest of rice scheme.
56. Dr. N. R. Dhar's scheme regarding nitrogen fixation in soils.
57. Investigation into the method of extraction of flax fibres in Bengal.

58. Research on cigarette tobacco at Guntur.
59. Investigation of virus diseases of plants.
60-63. Oilseed Research scheme—
    (*a*) Linseed—Bengal.
    (*b*) Linseed—Central Provinces.
    (*c*) Rape and mustard—Punjab.
    (*d*) Groundnuts—Madras.
64. Investigation of the 'root' disease of the coconut palm in South India.
65. Research on the changes in the microflora of *kallar* and alkaline soils in the Punjab.
66-69. Investigation into sunn-hemp cultivation in Bombay, Madras, Central Provinces and Bihar.
70. Special Locust Research Staff.
71. Locust Bureau.
72. Investigation of Indian fish poisons and other Indian forest products for their insecticidal properties.
73. Supply of decorticated cake for educative propaganda.
74. Wheat Milling and Baking Laboratory, Lyallpur.
75. Research on plant physiology, by Dr. Bosi Sen.
76. Research in agricultural economics at the Gokhale Institute of Politics and Economics.
77. Research in physiology of cane and wheat at the Benares Hindu University.
78. Survey of various fruit growing tracts of Baluchistan to determine the distribution and status as pest of the Codling Moth and Spilonata Ocellana.
79. Enquiry into production of cloves in India.
80. Botanical Sub-Station, Karnal.
81. Grant to Dacca University (Lateritic soils and nutrition of rice plant).

2. Sugar Schemes

1. Grant to Shahjahanpur Research Station for examination and study of sugarcane seedlings.
2. Bombay-Deccan Sugarcane Research scheme.
3. Scheme for the establishment of a Sugarcane Research Station in Bihar and for the appointment of a Sugarcane Specialist.
4. Scheme for the establishment of a Sub-station of the Coimbatore Imperial Sugarcane Station at Karnal.
5. Research on 'mosaic' and other cane diseases at New Delhi.
6. Sugarcane Seedling Testing Station, Dacca.
7. Grant to the Mysore Durbar for breeding of thick canes.
8. Research on the genetics of sugarcane at the Imperial Cane Breeding Station, Coimbatore.
9. Research on sugarcane in the Madras Presidency.
10. Establishment of a Sugarcane Research Station in the Punjab.
11. Investigation into various problems of sugar industry in the United Provinces.
12. Establishment of a Research and Testing Station for the indigenous system of gur and sugar manufacture by the Director, Imperial Institute of Sugar Technology.
13. Extension of sugarcane work at the Jorhat Experimental Station, Assam.
14. Bureau of Sugar Standards.

15. Economic enquiry into the cost of production of crops in the principal sugarcane and cotton tracts in India.
16. Research on insect pests of sugarcane.
17. Research on morphology and anatomy of sugarcane-sorghum hybrids and of the Indian sugarcane.
18. Research on the chemistry of sugarcane.
19. Investigation of suitable types of canes for Gujrat.
20. Utilization of bagasse for paper and board industry.
21. Sugarcane research in Hyderabad.
22. Sugarcane Beetle scheme, Burma.
23. Scheme regarding manufacture of cattle feed from molasses.

3. Animal Husbandry Schemes

1-11. Scheme for the appointment of Veterinary Investigation Officers in—
- (*a*) Madras.
- (*b*) Bombay.
- (*c*) Bengal.
- (*d*) United Provinces.
- (*e*) Punjab.
- (*f*) Bihar.
- (*g*) Central Provinces and Berar.
- (*h*) Assam.
- (*i*) North-West Frontier Province.
- (*j*) Sind and Ajmer-Merwara.
- (*k*) Hyderabad State.

12. Animal nutrition scheme, Bengal.
13. Animal nutrition scheme, Madras.
14. Scheme for research into indigenous fodders in Bihar.
15. Scheme for research into the composition of milk at the Allahabad Agricultural Institute.
16. Investigation of Johne's disease among cattle in Mysore.
17. Enquiry into the helminthiasis of cattle, sheep and goats in the United Provinces.
18. Appointment of a Systematic Protozoologist at the Imperial Veterinary Research Institute.
19. Improvement of poultry for table purposes in Northern India.
20. Bengal fresh water fishes scheme.
21. Sheep breeding scheme, Bombay.
22. Indigenous sheep breeding scheme, Punjab.
23. Scheme for the improvement of goats in the United Provinces.
24. Scheme for research in poultry industry to be conducted in Bombay.
25. Scheme for conducting research on Warble Flies at Mukteswar.
26. Investigation regarding vaccination of cattle against rinderpest.
27. Scheme for the establishment of pedigree herd books in India.
28. Scheme for the establishment of an All-India Animal Husbandry Bureau.
29. Scheme for practical research into feeding of cattle on departmental farms.
30. Investigations into most suitable and economic methods of combating different types of parasitic infection in field ruminants.
31. Enquiry regarding cattle and the production and consumption of milk.
32. Research at the Anand Creamery into manufacture of products and by-products of milk.

APPENDIX XV

List of Agricultural and Animal Husbandry Publications in India published during 1936-37

Title	Author	Where published
GENERAL AGRICULTURE		
Agriculture and Live-stock in India, Vol. VI, Parts 4, 5 and 6, Vol. VII, Parts 1 to 3. Annual subscription Rs. 6 or 9*s*. 9*d*. (A bi-monthly journal of agriculture and animal husbandry for the general reader interested in agriculture or live-stock in India or the Tropics).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
The Madras Agricultural Journal. Monthly. Annual subscription Rs. 4.	Published by the M. A. S. Union, Agricultural Research Institute, Coimbatore.	The Secretary, M. A. S. Union, Agricultural College, Lawley Road P. O.
The Journal of the Trichinopoly District Agricultural Association (English and Tamil). Quarterly. Annual subscription Re. 1-8-0 for non-members, free for members.	Issued by the Trichinopoly District Agricultural Association, Teppakulam Post.	The Secretary, The Trichinopoly District Agricultural Association, Teppakulam Post.
The Journal of the Mysore Agricultural and Experimental Union. Quarterly. Price As. 12 per copy.	V. K. Badami (Chief Editor).	The Secretary, the Mysore Agricultural and Experimental Union, Seshadri Road, Bangalore.
Mysore Vyavasaya Shodhaka Sanghada Patrike (Kannada). Monthly. Annual subscription Rs. 3. Single copy As. 4.	N. Venkatsubbaya (Chief Editor).	Ditto.
The Poona Agricultural College Magazine. Quarterly. Annual subscription Rs. 2-8-0.	V. G. Deshpande and S. M. Rao (Editors).	The Editor, *Poona Agricultural College Magazine*, Poona.
Shetki and Shetkari (Marathi). Monthly. Annual subscription Re. 1-3-0.	Vasudev Ganesh Pande .	The Editor, *Shetki and Shetkari*, Agricultural College, Poona.
The Planters' Journal and Agriculturist. Fortnightly. Annual subscription Rs. 10 or 16*s*.	Theo H. Thorne (Editor)	The Manager, *The Planters' Journal and Agriculturist*, 13, Ezra Mansions, Calcutta.
Krishi-Sampada (Bengali). Monthly. Annual subscription Rs. 3.	N. K. Ghosh (Editor) .	The Manager, *Krishi-Sampada* Office, Dacca.
Mufid-ul-Mazarain (Urdu) . .	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Kisan Upkarak (Hindi) . . .	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
The Allahabad Farmer. Bi-monthly. Annual subscription in India Rs. 2.	B. M. Pugh (Editor). Published by the Agricultural Institute, Allahabad.	The Allahabad Agricultural Institute, United Provinces (American Presbyterian Mission), Allahabad.
Seasonal Notes. Price As. 4 per copy	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
Kisan (Hindi). Quarterly. Annual subscription Rs. 2, As. 8 per copy.	Issued by the Agricultural Association, Bihar.	B. N. Sarkar, Senior Marketing Officer and Editor, *Kisan*, Patna.
The Nagpur Agricultural College Magazine. Quarterly. Annual subscription Rs. 3.	Published by P. D. Nair, Agricultural College, Nagpur.	The Editor, *The Nagpur Agricultural College Magazine*, College of Agriculture, Nagpur.
Agriculture and Animal Husbandry in India, 1933-34 and 1934-35. Part I —Crop Production, Price Rs. 4-14-0 or 8*s.*	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
Agriculture, and Animal Husbandry in India, 1935-36. Price Rs. 4-10-0 or 7*s.* 9*d.*	Ditto	Ditto.
Annual Report of the Imperial Council of Agricultural Research, 1936-37. Price Re. 1.	Ditto	Ditto.
Indian Central Cotton Committee—Its Objects, Activities and Achievements (Pamphlet in Gujarati, Marathi, Hindi and Urdu).	Secretary, Indian Central Cotton Committee.	Indian Central Cotton Committee, Bombay.
Indian Central Cotton Committee—A Brief Account of Its Objects and Achievements (Pamphlet in English, Urdu and Hindi).	Ditto	Ditto.
Indian Central Cotton Committee—Technological Laboratory, Matunga (Leaflet in English, Hindi and Urdu).	Ditto	Ditto.
Annual Report of the Indian Central Cotton Committee, Bombay, for the year ending 31st August 1936. Price Rs. 2.	Ditto	Ditto.
A Guide to Indian Cottons. Price As. 6.	Ditto	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Indian Central Cotton Committee—Its Objects, Activities and Achievements (Tamil and Telugu). Pamphlet (Gratis).	Secretary, Indian Central Cotton Committee.	Indian Central Cotton Committee, Bombay.
Summary Proceedings of the 33rd Half-yearly Meeting of the Indian Central Cotton Committee. Price Re. 1.	Ditto	Ditto.
Some Notes for the Use of State Agricultural Officers in Central India and Rajputana.	T. R. Low	Director, Institute of Plant Industry, Indore.
Instructions for the Cultivation of *Aleurites fordii* Tung Oil in Chota Nagpur (English and Hindi).	Dorothy Norris	Indian Lac Research Institute, Namkum, Ranchi.
Descriptive Note on Improved Strains from Important Varieties of Paddy evolved at the Agricultural Research Station, Maruteru (Telugu). Leaflet No. 72 of the Department of Agriculture, Madras.	K. Ramiah	Government Press, Madras.
Villagers' Calendar for 1936-37 (Malayalam).	Issued by the Department of Agriculture, Madras.	Ditto.
Villagers' Calendar for 1937 (English) .	Ditto	Ditto.
Villagers' Calendar for 1937-38 (Tamil, Telugu and Kanarese). Price Anna 1.	Ditto	Ditto.
Tamil Songs on Agriculture (Tamil). Leaflet No. 75 of the Department of Agriculture, Madras.	Ditto	Ditto.
Coconut Cultivation (Telugu, Kanarese and Malayalam). Pamphlet No. 8 of the Department of Agriculture, Madras. Free.	J. S. Patel	Ditto.
The Preparation of Infant and Invalid Foods in the Home from *Cholam*. Leaflet No. 5 of the Department of Agriculture, Madras. Free.	Ditto	Ditto.
No Water Rate of *Fasaljasti* for certain Crops; Concession made by Government to Ryots in aid of Cultivation (Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 7 of the Department of Agriculture, Madras. Free.	Ditto	Ditto.
A Short Note on Potato Cultivation. Leaflet No. 9 of the Department of Agriculture, Madras. Free.	Ditto	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
The Earth Scoop. Leaflet No. 78 of the Department of Agriculture, Madras.	N. G. Charley . .	Government Press, Madras.
Improved Turmeric Polisher. Leaflet No. 80 of the Department of Agriculture, Madras.	Ditto . . .	Ditto.
Note on Nilgiri Agriculture. Pamphlet No, 10 of the Department of Agriculture, Madras. Free.	D. G. Munro . . .	Ditto.
Some Practical Hints on Bee-keeping. Bulletin No. 37 of the Department of Agriculture, Madras. Reprinted.	S. Ramachandran . .	Ditto.
Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1935-36. Price As. 10.	Issued by the Department of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
Annual Report of the Department of Agriculture, Bengal, for 1935-36.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Calcutta.
Talk on Cultivation (Slogans). Leaflet No. 10 of 1936 of the Department of Agriculture, Bengal.	Ditto .	Ditto.
Jute Cultivation and Fibre Production. Leaflet No. 11 of 1936 of the Department of Agriculture, Bengal.	Ditto .	Ditto.
A Note on Bee-keeping for Exhibition (Note).	C. Maya Das . .	Newal Kishore Press, Lucknow.
Lawn-making (Hindi). (Leaflet) .	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Seed-sowing (Hindi). (Leaflet) . .	Ditto .	Ditto.
Hedges (Hindi). (Leaflet) . .	Ditto .	Ditto.
Rose Cultivation (Hindi). (Leaflet) .	Ditto .	Ditto.
Other Important Matter about Seeds (Hindi). (Leaflet.)	Ditto .	Ditto.
Transplanting. (Leaflet) . . .	Ditto .	Ditto.
R. D. Boring (Pamphlet) . . .	Ditto .	1. The Pioneer Press, Lucknow. 2. The Job Press, Cawnpore. 3. The Mercantile Press, Cawnpore.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Desi and Improved Ploughs (Hindi, Urdu and English). (Leaflet).	Issued by the Department of Agriculture, United Provinces.	1. The Pioneer Press, Lucknow. 2. The Job Press, Cawnpore. 3. The Mercantile Press, Cawnpore.
Hoes. (Leaflet)	Ditto .	Ditto.
Harrows. (Leaflet)	Ditto .	Ditto.
Threshers. (Leaflet). . . .	Ditto .	Ditto.
Winnowers. (Leaflet) . . .	Ditto .	Ditto.
Barn Machinery. (Leaflet) . .	Ditto .	Ditto.
Sugar Machinery for Open Pan System. (Leaflet.)	Ditto .	Ditto.
Olpad Thresher. (Leaflet) . .	Ditto .	Ditto.
Akola Hoe. (Leaflet) . . .	Ditto .	Ditto.
Lever Harrow. (Leaflet) . . .	Ditto .	Ditto.
Tractors. (Leaflet)	Ditto .	Ditto.
Chief Activities of Engineering Section with its Organisation and Headquarters. (Leaflet).	Ditto .	Ditto.
Rollers. (Leaflet)	Ditto .	Ditto.
Seed Drills. (Leaflet) . . .	Ditto .	Ditto.
Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1936. Price As. 5.	Ditto .	Government Printing and Stationery, United Provinces, Allahabad.
Hints for the Cultivation of Roses. Bulletin No. 69 of the Department of Agriculture (revised edition of Bulletin No. 36). Price As. 2.	R. D. Fordham . .	Ditto.
Vegetable growing in the Plains of the United Provinces. . Bulletin No. 70 of the Department of Agriculture, United Provinces. Price As. 4.	W. S. Smith . .	Ditto.
General Information about Sugarcane Crop in United Provinces. Leaflet No. 37 of the Department of Agriculture, United Provinces. Free.	Issued by the Department of Agriculture, United Provinces.	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Improved Methods of Cultivation and other Important Cultural Operations of Sugarcane. Leaflet No. 38 of the Department of Agriculture, United Provinces. Free.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Irrigation of Sugarcane Crop. Leaflet No. 39 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.
Manuring of Sugarcane Crop in the United Provinces. Leaflet No. 40 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.
The Utilisation of Molasses as a Manure for Sugarcane. Leaflet No. 41 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.
Ratooning of Sugarcane (English and Hindi). Leaflet No. 42 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.
The Elephant or Napier Grass (Urdu and Hindi). Leaflet No. 45 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.
The Berseem Grass (Urdu). Leaflet No. 46 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.
Linseed Cultivation in the United Provinces and its Importance in Indian Industries and Trade (Urdu). Leaflet No. 55 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.
Improved *Jowar* Varieties and their Importance in the United Provinces (Urdu). Leaflet No. 56 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.
Sunn-hemp Cultivation in the United Provinces and its Importance in the Indian Industries and Trade (Urdu). Leaflet No. 57 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Sanai ki karht aur san banane ki kuchh karamad batain (Urdu). Leaflet No. 60 of the Department of Agriculture, United Provinces. Free.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Green Manuring Sugarcane with *Sanai* (*Crotalaria juncea*).	R. L. Sethi; Aziz Dulah Khan and Ram Briksh Rao.	Ditto.
Cultivation and Curing of Cigarette Tobacco (English, Urdu and Hindi).	Issued by the Department of Agriculture, United Provinces.	Ditto.
Paddy Cultivation under Canal Irrigation.	Ditto .	Ditto.
Rotation in the Sugarcane Area .	Ditto .	Ditto.
The Use of Manures	Ditto .	Ditto.
Improved Implements and their Use .	Ditto .	Ditto.
An Agricultural Calendar for the Sarda Circle, United Provinces.	Ditto .	Ditto.
An Investigation on the Methods of Preparation and Standardization of Tomato Ketchup. Bulletin of the Department of Agriculture, Punjab. Price As. 4.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
Guide to Varieties of Cotton for 1937. Leaflet No. 135 of the Department of Agriculture, Punjab. Free.	Ditto .	Ditto.
A Short Summary of Important Results arrived at or indicated by the Field Experiments conducted by the Research Officers and Deputy Directors of Agriculture at the Central Research Institute, Lyallpur and the Agricultural Stations in the Punjab during 1936. Free.	Ditto .	Ditto.
Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1936. Price As. 8.	Ditto .	Ditto.
Annual Report of the Department of Agriculture, Bihar, 1935-36.	Issued by the Department of Agriculture, Bihar.	Government Press, Bihar, Gulzarbagh.
Annual Report on Experimental Farms in Bihar, 1935-36.	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*	
Cultivation of Berseem. Bulletin No. 4 of 1936 of the Department of Agriculture, Bihar.	Issued by the Department of Agriculture, Bihar.	Government Press, Bihar, Gulzarbagh.
A Note on Power Pumping Installation for Irrigation Purposes. Bulletin No. 1 of 1937 of the Department of Agriculture, Bihar. Free.	Ditto	Ditto.
The Role of Seed Unions in Village Uplift (English and Hindi). Leaflet No. 9 of 1936 of the Department of Agriculture, Central Provinces and Berar.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Printing, Central Provinces and Berar, Nagpur.
Report on the Agricultural College, Nagpur, for the year ending the 31st March 1936.	Ditto	Ditto.
Report on the Engineering Section, Agricultural College, Nagpur, for the year ending the 31st March 1936.	Ditto	Ditto.
Wheat Cultivation in Chhattisgarh and how to improve it (English and Hindi). Leaflet No. 7 of 1936 of the Department of Agriculture, Central Provinces and Berar.	Ditto	Ditto.
Protection of Crops against Damage from Frost (English and Hindi). Leaflet No. 8 of 1936 of the Department of Agriculture, Central Provinces and Berar.	Ditto	Ditto.
Annual Reports on Experimental Farms, Nagpur, Akola, Adhartal, Chhindwara, Powarkhera and Raipur, for the year ending the 31st March 1936. Price Re. 1-8-0.	Ditto	Ditto.
Improved Varieties of Crops recommended by the Agricultural Department for Chattisgarh (English and Hindi). Leaflet No. 11 of 1937 of the Department of Agriculture, Central Provinces and Berar.	Ditto	Ditto.
Cultivation of Onions (English, Hindi and Marathi). Leaflet No. 12 of 1937 of the Department of Agriculture, Central Provinces and Berar.	Ditto	Ditto.
Annual Report of the Department of Agriculture, Assam, for 1935-36.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Cuttack Farm. Leaflet No. 2 of 1936 of the Department of Agriculture, Orissa.	Issued by the Director of Development, Orissa.	Orissa Government Press, Cuttack.
Sambalpur Farm. Leaflet No. 3 of 1936 of the Department of Agriculture, Orissa.	Ditto	Ditto.
Angul Farm. Leaflet No. 4 of 1936 of the Department of Agriculture, Orissa.	Ditto	Ditto.
Kujang Farm. Leaflet No. 5 of 1936 of the Department of Agriculture, Orissa.	Ditto	Ditto.
Khurda Farm. Leaflet No. 6 of 1936 of the Department of Agriculture, Orissa.	Ditto	Ditto.
Balia Farm. Leaflet No. 7 of 1936 of the Department of Agriculture, Orissa.	Ditto	Ditto.
Puri Farm. Leaflet No. 8 of 1936 of the Department of Agriculture, Orissa.	Ditto	Ditto.
A Short Note on Research Work on Paddy in Orissa. Bulletin No. 6 of the Department of Agriculture, Orissa.	Ditto	Ditto.
Rahar. Bulletin No. 3 of the Department of Agriculture, Orissa.	Ditto	Ditto.
Annual Report of the Department of Agriculture in Sind, 1935-36.	Issued by the Department of Agriculture, Sind.	The Daily Gazette Press, Ltd., Karachi.
Annual Report on the Working of the Department of Agriculture, Hyderabad-Deccan for 1933-34.	Issued by the Department of Agriculture, Hyderabad.	Government Central Press, Hyderabad-Deccan.
Annual Experimental and Research Report of Hyderabad for 1932-33.	Ditto	Ditto.
Drama of *Premi Kisan*. Leaflet No. 18 of the Department of Agriculture, Hyderabad.	Ditto	Ditto.
Annual Administration Report of the Department of Agriculture, Hyderabad, for 1344F. (6th June 1934 to 5th June 1935). Price Rs. 2.	Issued by the Director of Agriculture, Hyderabad-Deccan.	Agricultural Directorate, Hyderabad-Deccan.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Report on the Experimental and Research work for 1343 F. Price Rs. 2.	Issued by the Director of Agriculture, Hyderabad-Deccan.	Agricultural Directorate, Hyderabad-Deccan.
Annual Administration Report of the Department of Agriculture, Mysore State, for the year 1934-35. Price Re. 1-8-0.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.
Mysore Agricultural Calendar for 1937 (English and Kannada). Price English As. 2; Kannada Anna 1.	Ditto	Director of Agriculture, Mysore, Bangalore.
Annual Report of the Coffee Scientific Officer, Mysore, 1936-37. Mysore Coffee Experiment Station Bulletin No. 16. Price As. 4.	W. W. Mayne	Ditto.
Ploughing	N. Narayanan Tampi	Government Press, Travancore, Trivandrum.
Soya Bean (Malayalam)	T. C. Kochunni Pillai	Ditto.
Iron Plough (Tamil)	P. Padmanabha Iyer	Ditto.
Tomato Cultivation	M. Madhavan	Ditto.
Growing Trees for Timber, Fuel and Green Manure.	Issued by the Department of Agriculture, Cochin.	Cochin Government Press, Ernaculam.
A Kind of Poison found in the Leaf of Rubber.	Ditto	Ditto.
A Kind of Furnace for the Preparation of Arecanut for Chewing Purposes (Malayalam). (Leaflet.)	Ditto	Ditto.
Bee-keeping in the State (Malayalam). (Bulletin.)	Ditto	Ditto.
Memoranda on the History, Activities and Policy of the United Planters' Association, Southern India. Tea Scientific Department.	Issued by the United Planters' Association of Southern India.	United Planters' Association for Southern India, Glenview, Coonoor, Nilgiris.
Annual Administration Reports of the Tea and Coffee Scientific Officers of the United Planters' Association of Southern India for the year 1936-37.	Ditto	Ditto.
Betel Nut in Burma. Agricultural Survey No. 25 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*concld.*		
The Cultivation of Betel Nut. Cultivators' Leaflet No. 80 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
Lay-out and Anti-erosion Measures in the Dry Zone (Burmese). Cultivators' Leaflet No. 81 of the Department of Agriculture, Burma.	Ditto	Ditto.
Onion Cultivation in the Northern Circle. Bulletin No. 31 of the Department of Agriculture, Burma.	Ditto	Ditto.
Market Surveys of Burma Crops. Bulletin No. 32 of the Department of Agriculture, Burma.	Ditto	Ditto.
AGRICULTURAL STATISTICS		
Supply and Distribution of the Various Types of Indian Cotton during the season of 1934-35. Statistical Bulletin No. 5 (1934-35). Price As. 8.	Issued by the Secretary, Indian Central Cotton Committee.	Indian Central Cotton Committee, Bombay.
Stocks of Indian Raw Cotton held in India by the Mills and the Trade on 31st August, 1936. Statistical Leaflet No. 2. Third Issue (1935-36).	Ditto	Ditto.
Receipts at Mills in India of Raw Cotton Classified by Varieties (1935-36 season). Statistical Leaflet No. 3. Third Issue (1935-36). Price Anna 1.	Ditto	Ditto.
Exports by Seas of Indian Raw Cotton Classified by Varieties (1935-36 season). Statistical Leaflet No. 4. Third Issue (1935-36). Price Anna 1.	Ditto	Ditto.
Report on the Accuracy of the All-India Cotton Forecasts of 1934-35 and 1935-36 season. Statistical Leaflet No. 5. First Issue (1935-36). Price As. 2.	Ditto	Ditto.
Report on the Staple Length of Indian Cotton Crop of 1936-37 season. Statistical Leaflet No. 1. Fourth Issue (1936-37). Price Anna 1.	Ditto	Ditto.
Season and Crop Report of the Bombay Presidency, for the year 1935-36. Price As. 6.	Issued by the Department of Agriculture, Bombay Presidency.	Government Central Press, Bombay.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
AGRICULTURAL STATISTICS—*concld.*		
Season and Crop Report of Bengal for 1936-37. Price As. 4.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Calcutta.
Quinquennial Report on the Crop Cutting Experiments of Bengal for the years 1932-33 to 1936-37. Price As. 4.	Ditto	Ditto.
Season and Crop Report of the Punjab for the year ending 30th June 1936. Price Rs. 3-8-0 per copy.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
Agricultural Statistics, Bihar, 1935-36. Price Rs. 2.	Issued by the Department of Agriculture, Bihar.	Government Press, Bihar, Gulzarbagh.
Season and Crop Report, Sind, 1935-36	Issued by the Department of Agriculture, Sind.	The Daily Gazette Press, Ltd., Karachi.
SUGAR RESEARCH		
Notes on Sugarcane Cultivation in Bengal. Leaflet No. 9 of 1936 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Calcutta.
Improved Methods of Cane Cultivation in the United Provinces.	R. L. Sethi; B. N. Pramanik; Aziz Dulah Khan and Ram Briksh Rao.	Government Printing and Stationery, United Provinces, Allahabad.
Open Pan Boiling for *Gur* and Sugar Manufacture. Leaflet No. 43 of the Department of Agriculture, United Provinces. Free.	Issued by the Department of Agriculture, United Provinces.	Ditto.
Cultivation of Sugarcane in Chota Nagpur. Bulletin No. 5 of 1936 of the Department of Agriculture, Bihar.	Issued by the Department of Agriculture, Bihar.	Government Press, Bihar, Gulzarbagh.
Manuring of Sugarcane in Bihar by Agricultural Chemist. Leaflet No. 3 of 1936 of the Department of Agriculture, Bihar.	Ditto	Ditto.
A Brief Note on Sugarcane Research Work done by the Department during the last 4 years and its Significance to the Sugarcane Industry in Bihar. Leaflet No. 4 of 1936 of the Department of Agriculture, Bihar.	Ditto	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
SUGAR RESEARCH—*concld.*		
How to Distinguish Co. 331 from Co. 213 (with a Diagram). Free.	Issued by the Department of Agriculture, Bihar.	Government Press, Bihar, Gulzarbagh.
Instructions for Sampling of Cane at the Farm. Leaflet No. 3 of 1937 of the Department of Agriculture, Bihar.	Ditto	Ditto.
Some Hints to Sugarcane Cultivators	V. Narayanan Nair	Government Press, Travancore, Trivandrum.
Sugarcane Cultivation (Malayalam)	Issued by the Department of Agriculture, Cochin, Trichur.	Cochin Government Press, Ernaculam.
COTTON TECHNOLOGY		
The Effect of Employing different Roller Settings and Twists on the Spinning Performance of Three Indian Cottons. Series A (Tech. Bull. No. 32). Price As. 8.	R. P. Richardson and Nazir Ahmad.	Indian Central Cotton Committee, Bombay.
Technological Reports on Standard Indian Cottons, 1936. Series A (Tech. Bull. No. 33). Price Re. 1-8-0.	Nazir Ahmad	Ditto.
The Effect of Raising the Middle Roller and some other Factors on the Yarn Strength of Sindhi Cotton. Series A (Tech. Bull. No. 34). Price As. 8.	Ditto	Ditto.
Technological Reports on Trade Varieties of Indian Cottons, 1936. Series A (Tech. Bull. No. 35). Price Re. 1-8-0.	Ditto	Ditto.
Spinning Tests on Mixtures of Staple Fibres and Indian Cottons. Series A (Tech. Bull. No. 36). Price As. 8.	Ditto	Ditto.
Further Tests on Indian Cottons with Different Systems of High Draft Spinning. Series A (Tech. Bull. No. 37). Price Re. 1.	R. P. Richardson and Nazir Ahmad.	Ditto.
A New Method and Apparatus for Determining the Average Length and Fineness of Cotton Hairs. Series B (Tech. Bull. No. 21). Price As. 8.	Nazir Ahmad and C. Nanjundayya.	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
COTTON TECHNOLOGY—*contd.*		
Spinning Test and Technological Reports on 1936-37 samples of:— Cambodia Co. 2 (Cambodia 440) Technological Circular No. 225.	Nazir Ahmad . .	Indian Central Cotton Committee, Bombay.
Navsari Cotton (Technological Circular No. 226).	Ditto . .	Ditto.
Surat Cotton (Technological Circular No. 227).	Ditto . .	Ditto.
Bailhongal Cotton (Technological Circular No. 228).	Ditto . .	Ditto.
Tiruppur Cambodia Cotton (Technological Circular No. 229).	Ditto . .	Ditto.
Broach Cotton (Technological Circular No. 230).	Ditto . .	Ditto.
Sind Sudhar (289-F-1) (Technological Circular No. 231).	Ditto . .	Ditto.
Farm Westerns Cotton (Technological Circular No. 232).	Ditto . .	Ditto.
Westerns Cotton (Technological Circular No. 233).	Ditto . .	Ditto.
Hubli Kumpta Cotton (Technological Circular No. 234).	Ditto . .	Ditto.
Hubli Upland Cotton (Technological Circular No. 235).	Ditto . .	Ditto.
Navsari Cotton (Technological Circular No. 236).	Ditto . .	Ditto.
Surat Cotton (Technological Circular No. 237).	Ditto . .	Ditto.
Jagadia Cotton (Technological Circular No. 238).	Ditto . .	Ditto.
Kadi Cotton (Technological Circular No. 239).	Ditto . .	Ditto.
Surat 1027 A. L. F. (Technological Circular No. 240).	Ditto . .	Ditto.
Dholleras Cotton (Technological Circular No. 241).	Ditto . .	Ditto.
Broach Cotton (Technological Circular No. 242).	Ditto . .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
COTTON TECHNOLOGY—*contd.*		
Spinning Test and Technological Reports on 1936-37 samples of:—		
Jagadia Cotton (Technological Circular No. 243).	Nazir Ahmad . .	Indian Central Cotton Committee, Bombay.
Berar Cotton (Technological Circular No. 244).	Ditto . .	Ditto.
African Busoga (Technological Circular No. 245).	Ditto . .	Ditto.
Jinja (Technological Circular No. 246)	Ditto . .	Ditto.
Khandesh Cotton (Technological Circular No. 247).	Ditto . .	Ditto.
Kampala Cotton (Technological Circular No. 248).	Ditto . .	Ditto.
Miraj Cotton (Technological Circular No. 249).	Ditto . .	Ditto.
Tiruppur Cambodia (Technological Circular No. 250).	Ditto . .	Ditto.
Karunganni Cotton (Technological Circular No. 251).	Ditto . .	Ditto.
Northern Cambodia (Technological Circular No. 252).	Ditto . .	Ditto.
Farm Westerns (Technological Circular No. 253).	Ditto . .	Ditto.
Upland Cotton (Technological Circular No. 254).	Ditto . .	Ditto.
Kadi Viramgam (Technological Circular No. 255).	Ditto . .	Ditto.
Bijapur Cotton (Technological Circular No. 256).	Ditto . .	Ditto.
Kalajin Cotton (Technological Circular No. 257).	Ditto . .	Ditto.
Bagalkote Cotton (Technological Circular No. 258).	Ditto . .	Ditto.
Cambodia Cotton (Technological Circular No. 259).	Ditto . .	Ditto.
Tinnevelley Cotton (Technological Circular No. 260).	Ditto . .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
COTTON TECHNOLOGY—*contd.*		
Spinning Test and Technological Reports on 1936-37 samples of:—		
Karunganni Cotton (Technological Circular No. 261).	Nazir Ahmad . .	Indian Central Cotton Committee, Bombay.
A. R. Jinja Cotton (Technological Circular No. 262).	Ditto . .	Ditto.
A. R. Busoga Cotton (Technological Circular No. 263).	Ditto . .	Ditto.
A. R. Kampala Cotton (Technological Circular No. 264).	Ditto . .	Ditto.
Westerns Javaria Cotton (Technological Circular No. 265).	Ditto . .	Ditto.
Kumpta Cotton (Technological Circular No. 266).	Ditto . .	Ditto.
Verum 262 (Akola) (Technological Circular No. 267).	Ditto . .	Ditto.
Verum 434 (Akola) (Technological Circular No. 268).	Ditto . .	Ditto.
Umri Bani Cotton (Technological Circular No. 269).	Ditto . .	Ditto.
Bagalkote Cotton (Technological Circular No. 270).	Ditto . .	Ditto.
Khandesh Cotton (Technological Circular No. 271).	Ditto . .	Ditto.
Ujjain Cotton (Technological Circular No. 272).	Ditto . .	Ditto.
Ujjain Cotton (Technological Circular No. 273).	Ditto . .	Ditto.
Moglai Cotton (Technological Circular No. 274).	Ditto . .	Ditto.
Verum 262 (Nagpur) (Technological Circular No. 275).	Ditto . .	Ditto.
Berar Cotton (Technological Circular No. 276).	Ditto . .	Ditto.
C. P. No. 1 (Technological Circular No. 277).	Ditto . .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
COTTON TECHNOLOGY—*concld.*		
Spinning Test and Technological Reports on 1936-37 Samples of :—		
Khandesh Cotton (Technological Circular No. 278).	Nazir Ahmad . .	Indian Central Cotton Committee, Bombay.
Late Verum (Nagpur) (Technological Circular No. 279).	Ditto . .	Ditto.
Punjab-American 289F (Technological Circular No. 280).	Ditto . .	Ditto.
Farm Westerns Cotton (Technological Circular No. 281).	Ditto . .	Ditto.
Broach Cotton (Technological Circular No. 282).	Ditto . .	Ditto.
FRUITS		
Papaya or *Papeeta*. Bulletin No. 2 of the Department of Agriculture, United Provinces (Fruit Series). (Revised).	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Notes on Fruit Culture in the Hills (Hindi). Bulletin No. 10 of the Department of Agriculture, United Provinces (Fruit Series). (Revised).	Ditto .	Ditto.
Preparation of Guava Jelly (Urdu and Hindi). Leaflet No. 61 of the Department of Agriculture, United Provinces. Free.	Ditto .	Ditto.
Pruning of Deciduous Fruit Trees. Bulletin No. 18 of the Department of Agriculture, United Provinces. Price As. 2-6.	R. S. Singh . . .	Ditto.
Manuring of Orangēs (Reprint). Leaflet.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces and Berar, Nagpur.
Cultivation of Pomegranate (Urdu). Leaflet No. 5 of the Department of Agriculture, Hyderabad.	Issued by the Department of Agriculture, Hyderabad.	Government Central Press, Hyderabad, Deccan.
Cultivation of Figs (Urdu). Leaflet No. 6 of the Department of Agriculture, Hyderabad.	Ditto .	Deputy Director of Agriculture and Horticulturist, Hyderabad.
Cultivation of Oranges. Leaflet No. 7 of the Department of Agriculture, Hyderabad. Free.	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
FRUITS—*concld.*		
Cultivation of Mangoes. Leaflet No. 8 of the Department of Agriculture, Hyderabad. Free.	Issued by the Department of Agriculture, Hyderabad.	Deputy Director of Agriculture and Horticulturist, Hyderabad.
Budding of Lime Plants . . .	P. K. Krishna Pillai .	Government Press, Travancore, Trivandrum.
Banana Cultivation	P. O. Abraham . .	Ditto.
Mango Grafts and other Fruit Plants. (Reprint of leaflet published in 1931).	Issued by the Department of Agriculture, Cochin.	Cochin Government Press, Ernaculam.
Burma Fruits and their Cultivation. Bulletin No. 30 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
LAC		
The Shellac Industry . . .	Issued by the Indian Lac Research Institute, Namkum, Ranchi.	Director, Indian Lac Research Institute, Namkum, Ranchi.
Annual Report of the Indian Lac Research Institute for financial year 1935-36.	Ditto .	Ditto.
Annual Report of the Indian Lac Research Institute for financial year 1936-37, May 1937.	Ditto .	Ditto.
Some Information and Advice to Shellac Manufacturers, 1937.	Ditto .	Ditto.
Some Analytical Data for Pure Shellacs, 1937.	Ditto .	Ditto.
Estimation of Orpiment in Shellac. Bulletin No. 26. Price As. 2.	M. Rangaswami and H. K. Sen.	Ditto.
Some Simple Methods of Reducing the Damage done by Insect Enemies to the Lac Crops (English, Hindi, Uriya and Bengali). Bulletin No. 23.	P. M. Glover . .	Ditto.
The Use of *Schleichera Trijuga* (*Kusum*) in Lac Cultivation. Bulletin No. 24. Price 9 pies.	Dorothy Norris . .	Ditto.
Use of the Quinhydrone and Antimony Electrodes for Potentiometric Titrations of Resin Solution. Bulletin No. 25. Price As. 3.	Narasimha Murty and Harold Weinberger with Wm. Howlett Gardner.	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
AGRICULTURAL SCIENCE		
GENERAL		
The Indian Journal of Agricultural Science, Vol. VI, Parts 4-6; Vol. VII, Parts 1 to 3. Annual subscription Rs. 15 or 24*s*. (Original scientific work in the various branches of science applied to agriculture, formerly published in the Memoirs of the Imperial Department of Agriculture in India is now published in the *Indian Journal of Agricultural Science*).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
Tables of Standard Errors of Mendelian Ratios. Miscellaneous Bulletin No. 11 of the Imperial Council of Agricultural Research.	Swarn Singh Purewal and P. Krishna Rao.	Ditto.
Two New Statistical Tables based upon Fishers' '*t*', Miscellaneous Bulletin No. 13 of the Imperial Council of Agricultural Research.	M. Vaidyanathan . .	Ditto.
Scientific Reports of the Imperial Institute of Agricultural Research, Pusa, for the year 1934-35 including the Reports of the Dairy Expert, Physiological Chemist and Sugarcane Expert.	Issued by the Director, Imperial Institute of Agricultural Research, Pusa.	Ditto.
Scientific Reports of the Imperial Agricultural Research Institute, New Delhi, for the year 1935-36 including the Reports of the Sugarcane Expert.	Issued by the Director, Imperial Agricultural Research Institute, New Delhi.	Ditto.
Scientific Report of the Sugarcane Research Station, Bihar and Orissa, for the year ending 31st March 1935. Bulletin No. 2 of 1936 of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar, Gulzarbagh.
Scientific Report of the Sugarcane Research Station, Bihar and Orissa, for the year ending 31st March 1936. Bulletin No. 3 of 1936 of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
AGRICULTURAL SCIENCE—*contd.*		
BOTANY		
List of Publications on the Botany of Indian Crops, Part II, for the period 1928-29, Miscellaneous Bulletin No. 12 of the Imperial Council of Agricultural Research. Price Rs. 3-6-0 or 5*s.* 9*d.*	R. D. Bose . . .	Manager of Publications, Delhi.
The Distribution of Gossypium and the Evolution of the Commercial Cottons. Paper No. 7 of the Indian Central Cotton Committee.	J. B. Hutchinson . .	Director, Institute of Plant, Industry, Indore.
Improvement of Rice in the Bombay Karnatak, Part I—Selections in the Mugad and Antarsal Varieties of Paddy. Price As. 3.	Issued by the Department of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
Inheritance of Earliness in the United Provinces Rices.	R. L. Sethi ; B. L. Sethi and T. R. Mehta.	Government Printing and Stationery, United Provinces, Allahabad.
Studies in Indian Millets . . .	T. S. Sabnis . . .	Ditto.
Report on the Botanical Section, Agricultural College, Nagpur, for the year ending 31st March 1936.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Printing, Central Provinces and Berar, Nagpur.
CHEMISTRY AND PHYSICAL CHEMISTRY		
The Use of Manures in the Madras Presidency (English, Tamil and Malayalam). Pamphlet No. 9 of the Department of Agriculture, Madras. Free.	P. Venkataramiah . .	Government Press, Madras.
Mineral Constituents of Food Grains, Vegetables and Cattle Feeds of Western India. Bulletin No. 179 of 1936 of the Department of Agriculture, Bombay Presidency. Price Anna 1.	D. L. Sahsrabuddhe .	Government Central Press, Bombay.
Report on the Chemical Section, Agricultural College, Nagpur, for the year ending 31st March 1936.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Printing, Central Provinces and Berar, Nagpur.
Preparation of Artificial Farmyard Manure from Surplus Waste Materials from the Fields (English, Hindi and Marathi). Leaflet No. 13 of 1937 of the Department of Agriculture, Central Provinces and Berar. Revised. Price Re. 1-8-0.	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
AGRICULTURAL SCIENCE—*contd.*		
CHEMISTRY AND PHYSICAL CHEMISTRY—*concld.*		
Green Manuring	Issued by the Department of Agriculture, Cochin.	Cochin Government Press, Ernaculam.
Report on Manurial Experiments carried out in Burma by the Agricultural Department from 1912-13 to 1930-31. Bulletin No. 29 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
The Preparation of Starch and Dextrin from Broken Rice. Bulletin No. 33 of the Department of Agriculture, Burma. Price As. 2.	S. P. Aiyar . . .	Ditto.
The Preparation of Useful Products from Citrus Fruits. Price As. 2.	Ditto . . .	Ditto.
The Preparation of Starch from Broken Rice. Leaflet No. 82 of the Department of Agriculture, Burma. Free.	Ditto . . .	Director of Agriculture, Burma, Rangoon.
ENTOMOLOGY		
The Spotted Boll-worms of Cotton in South Gujarat. Scientific Monograph No. 10 of the Imperial Council of Agricultural Research. Price Rs. 5-14-0 or 9*s.* 6*d.*	B. P. Deshpande and N. T. Nadkarny.	Manager of Publications, Delhi.
List of Publications on Indian Entomology, 1935. Miscellaneous Bulletin No. 14 of the Imperial Council of Agricultural Research. Price Re. 1-4-0.	Compiled by the Imperial Entomologist, Imperial Institute of Agricultural Research, Pusa.	Ditto.
Pink Boll-worm Pest of Cotton and how to Control it.	Secretary, Indian Central Cotton Committee.	Indian Central Cotton Committee, Bombay.
The Mango Hopper. Leaflet No. 77 of the Department of Agriculture, Madras.	M. C. Cherian . .	Government Press, Madras.
Red Hairy Caterpillar Pest (Telugu and Tamil). Leaflet No. 9 of the Department of Agriculture, Madras. Free.	Issued by the Department of Agriculture, Madras.	Ditto.
Insect Diseases and their Remedies (Hindi).	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
AGRICULTURAL SCIENCE—*contd.*		
ENTOMOLOGY—*concld.*		
The Pink Boll-worm of Cotton and its Control. Leaflet No. 10 of the Department of Agriculture, Central Provinces and Berar (English, Hindi and Marathi).	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Printing, Central Provinces and Berar, Nagpur.
Report on the Entomological Research, Agricultural College, Nagpur, for the year ending 31st March 1936.	Ditto	Ditto.
Insect Pests of Crops. Bulletin No. 5 of the Department of Agriculture, Orissa.	Issued by the Director of Development, Orissa.	Orissa Government Press, Cuttack.
Insect Pests on Mustard and *Mung*. Bulletin No. 4 of the Department of Agriculture, Orissa.	Ditto	Ditto.
How to send Insect Specimens for Identification. Leaflet No. 20 of the Department of Agriculture, Hyderabad.	Issued by the Department of Agriculture, Hyderabad.	Government Central Press, Hyderabad-Deccan.
Coffee Stem Borer (*Xylotrechus Quadripes* Cherr.) and its Control. Circular No. 57 of the Department of Agriculture, Mysore.	Issued by the Department of Agriculture, Mysore.	Director of Agriculture, Mysore, Bangalore.
Some Plant Pests found in Flower Gardens.	Issued by the Department of Agriculture, Cochin.	Cochin Government Press, Ernaculam.
Two Types of Paddy Grass Hoppers .	Ditto	Ditto.
Contheyla rotunda which attacks Coconut Trees, Plantain Leaves and Arecanut Trees (Malayalam).	Ditto	Ditto.
PLANT DISEASES		
Diseases of Sugarcane and Methods for their Control. Miscellaneous Bulletin No. 10 of the Imperial Council of Agricultural Research. Price Re. 1-14-0 or 3*s.* 3*d.*	L. S. Subrahmaniam	Manager of Publications, Delhi.
The Leaf Curl Disease of Chillies. Leaflet No. 73 of the Department of Agriculture, Madras (English and Telugu).	M. C. Cherian	Government Press, Madras.
Bud Rot on Coconut Palms in Malabar District. Leaflet No. 74 of the Department of Agriculture, Madras (English and Malayalam).	McRae and F. T. Shaw	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
AGRICULSURAL SCIENCE—*concld.*		
PLANT DISEASES—*concld.*		
Mehâli Disease of Arecanuts in South Kanara (English and Kanarese).	K. T. Alwa . . .	Government Press, Madras.
Angular Leaf Spot of Cotton. Leaflet No. 138 of the Department of Agriculture, Punjab. Free.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
Report on the Mycological Research, Agricultural College, Nagpur, for the year ending 31st March 1936.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Printing, Central Provinces and Berar, Nagpur.
Factors affecting Spray Success in the Control of Coffee Leaf Disease (*Hemileia Vastatrix* B. and Br.). Bulletin No. 15 of the Mysore Coffee Experiment Station.	W. W. Mayne . .	Director of Agriculture, Mysore, Bangalore.
Coconut Leaf Disease in Cochin, Kanayannur Taluk.	Issued by the Department of Agriculture, Cochin.	Cochin Government Press, Ernaculam.
Pink Disease. United Planters' Association, Southern India. Tea Scientific Department Bulletin No. 10.	M. K. Subba Rao . .	United Planters'. Association of Southern India, Glenview, Coonoor, Nilgiris.
VETERINARY SCIENCE AND ANIMAL HUSBANDRY		
Agriculture and Live-stock in India, Vol. VI, Parts 4, 5 and 6, Vol. VII, Parts 1 to 3. Annual subscription Rs. 6 or 9*s.* 9*d.* (A bi-monthly journal of agriculture and animal husbandry for the general reader interested in agriculture or live-stock in India or the Tropics).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
The Indian Journal of Veterinary Science and Animal Husbandry, Vol. VI, Parts 3 and 4; Vol. VII, Parts 1 and 2. Annual subscription Rs. 6 or 9*s.* 9*d.* (A quarterly journal for the publication of scientific matter relating to the health, nutrition and breeding of live-stock).	Ditto .	Ditto.
The Indian Veterinary Journal (The Journal of the All-India Veterinary Association). Quarterly. Annual subscription Rs. 4 or 6*s.* 6*d.* for members and Rs. 8 or 10*s.* for others.	P. Srinivasa Rao (Editor)	The Editor, *The Indian Veterinary Journal*, 26, Wallajah Road, Madras.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
The United Provinces Veterinary Magazine (English and Urdu). Monthly. Issued free to members of the United Provinces Veterinary Association.	A. W. Hameed (Editor) .	The Editor, *United Provinces Veterinary Magazine*, Moradabad.
The Punjab Veterinary Journal . .	Issued by the Punjab Veterinary Association.	The Editor, *The Punjab Veterinary Journal*, Lahore.
The Central Provinces Veterinary Journal. quarterly.	Issued by the Central Provinces Veterinary Association.	The Honorary Secretary, Central Provinces Veterinary Association, Nagpur.
Agriculture and Animal Husbandry in India, 1933-34 and 1934-35, Part II —Animal Husbandry. Price Re. 1 or 1*s.* 9*d.*	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
Investigations on the Course and Distribution of the Nerves supplying Levator Anguli Scapuli and Rhomboideus Muscles and the formation of the Phrenic Nerve in the Ox, with Observations on certain Anatomical Deviations. Scientific Monograph No. 11 of the Imperial Council of Agricultural Research. Price Rs. 4-10-0.	H. N. Chelva Ayyangar .	Ditto.
Annual Report of the Imperial Dairy Expert for the year 1935-36. Price Re. 1-4-0 or 2*s.*	Issued by the Imperial Dairy Expert.	Ditto.
Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March 1936.	Issued by the Director, Imperial Institute of Veterinary Research, Muktesar.	Ditto.
Cattle Breeding (Tamil, Telugu, Kanarese and Malayalam, already published in English). Leaflet No. 70.	R. W. Littlewood .	Government Press, Madras.
Breeding Bulls and their Management (Tamil, Telugu and Kanarese, already published in English). Leaflet No. 71.	Ditto .	Ditto.
Conditions to be fulfilled for the Grant of Premium for Breeding Bulls maintained by Private Bodies (Reprinted).	Issued by the Department of Agriculture, Madras.	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
Rations for Milch Cows, Dry Cows, Calves, etc. (Telugu). Leaflet No. 16 of the Department of Agriculture, Madras. Free.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
Live-stock of Southern India. Bulletin. Price Rs. 3-6-0.	R. W. Littlewood . .	Ditto.
Some Advantages of Poultry Keeping (Tamil, Telugu, Kanarese and Malayalam). (Reprinted.) Leaflet No. 54 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
Natural Incubation of Poultry (English, Tamil, Kanarese and Malayalam). (Reprinted.) Leaflet No. 55 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
Brooding and Rearing of Chicks (Reprinted). Leaflet No. 56 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
Housing of Poultry (Reprinted). Leaflet No. 57 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
Book on Live-stock of Southern India	Ditto . .	Ditto.
Conditions to be fulfilled for the Grant of Premium for Breeding Bulls (Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 2 of the Department of Agriculture, Madras. (Reprinted.)	Issued by the Department of Agriculture, Madras.	Ditto.
Note on the Possibilities of Hormone Treatment for Slow Breeding in Cows and Bulls.	P. J. Kerr . . .	Bengal Government Press, Alipore, Calcutta.
A Review of the Position in regard to the Incidence and Control of Diseases of Sheep and Goats that are Important from the Point of View of Export of these Animals from India.	Balwant Singh . .	Ditto.
Better Cattle. Leaflet No. 8 of 1936 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Ditto.
Annual Report of the Civil Veterinary Department, Bengal, for the year 1935-36.	Issued by the Civil Veterinary Department, Bengal.	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—contd.

Title	Author	Where published
VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
Report on the Sheep Breeding Industry in Upper Garhwal.	T. J. Egan . . .	Government Printing and Stationery, United Provinces, Allahabad.
List of Horse and Cattle Fairs and Shows in the Punjab and Punjab States, for the *Fasli* year 1936-37.	Issued by the Director, Veterinary Services, Punjab.	Government Printing, Punjab, Lahore.
Annual Report of the Civil Veterinary Department, Punjab, for the year 1935-36.	Ditto .	Ditto.
Live-stock at the Government Cattle Farm, Hissar. Veterinary Bulletin No. 7 of 1936 of the Department of Veterinary Services, Punjab.	Ditto .	Ditto.
Review of the Warble Fly Pest in India. Veterinary Bulletin No. 9 of 1936 of the Department of Veterinary Services, Punjab.	Ditto .	Ditto.
Mange in Sheep. Veterinary Leaflet No. 5 of the Department of Veterinary Services, Punjab.	Ditto .	Ditto.
Prospectus of Punjab Veterinary College, Lahore, for the Session 1937-38.	Ditto .	Ditto.
Sheep Husbandry in the Punjab. Veterinary Bulletin No. 10 of 1937 of the Department of Veterinary Services, Punjab. Free.	L. W. Smith and Mumtaz Husain.	Ditto.
An Improved Poultry House for Villages. Leaflet No. 137 of the Department of Agriculture, Punjab. Free.	Issued by the Department of Agriculture, Punjab.	Ditto.
Gopalan (Hindi). Leaflet No. 2 of 1937 of the Department of Agriculture, Bihar. Free.	Issued by the Department of Agriculture, Bihar.	Government Press, Bihar, Gulzarbagh.
Report on the Maharajbagh Menageries together with the External Work of the Veterinary Inspector attached to the Agricultural College, Nagpur, for the year ending 31st March, 1936.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Printing, Central Provinces and Berar, Nagpur.
Conditions on which Bulls will be given out by the Agricultural Department for Improvement of Cattle (English and Marathi). Leaflet. Price Re. 1-8-0.	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1936-37—concld.

Title	Author	Where published
VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*concld.*		
Annual Report of the Civil Veterinary Department, Assam, for the year 1935-36.	Issued by the Civil Veterinary Department, Assam.	Government Press, Assam Shillong.
Use of Oilcake as Fodder for Cattle. Bulletin No. 1 of the Department of Agriculture, Orissa.	Issued by the Director of Development, Orissa.	Orissa Government Press, Cuttack.
Poultry Survey Report (Urdu). Bulletin No. 7 of the Department of Agriculture, Hyderabad.	Issued by the Department of Agriculture, Hyderabad.	Government Central Press, Hyderabad-Deccan.
Brief Instructions for the Guidance of Lay Persons regarding Improvement of Animal Industry, Chiefly Cattle, Sheep and Poultry. Circular No. 56 of the Department of Agriculture, Mysore.	A. A. Monteiro . .	Government Press, Bangalore.
Some Do's and Don'ts in regard to Poultry and Sheep Breeding. Circular No. 58 of the Department of Agriculture, Mysore.	Ditto . .	Director of Agriculture, Mysore, Bangalore.
Annual Report of the Civil Veterinary Department, Mysore.	Issued by the Civil Veterinary Department, Mysore.	Government Press, Bangalore.
Cattle Shed and its Premises. Issued by the Department of Agriculture, Travancore.	K. Krishna Pillai .	Government Press, Travancore, Trivandrum.

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